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Space Policy, Administration

Prospects Dim For Cosmonauts Trained For Buran Missions

937Q0119A Moscow NEZAVISIMAYA GAZETA in Russian 13 Apr 93 p 6

[Article by Valeriy Ageyev: " 'Buran' Test Pilots. They Have Become Hostages of the System"]

[Text] They lie alongside one another in the Bykovskoye Cemetery in Moscow: Oleg Kononenko, Anatoliy Levchenko and Aleksandr Shchukin. A fourth, Rimas Stankyavichyus, is buried in Lithuania. These were test pilots from the first group of the space detachment organized for flight on the Soviet multireuseable Buran spaceship. Not one of them rose into space in the Buran. Kononenko was the first to die in the abyss of the sea during a takeoff from an aircraft carrier. Then Levchenko died from cancer, but not until after seeing the stars from a port of the Soyuz-TM-4. Two weeks after his death Shchukin crashed in a sports aircraft. Stankyavichyus perished in hellish flames together with his Su-27 superfighter.

Today the Buran orbital ship is in mothballs and its first test pilots have long been dead. Who would have thought in the quiet 1970's, the years of flourishing of Soviet space research, that the launching of the Energiya-Buran system, this grandiose measure "along space lines," would end so pitifully?

After the successful Buran launching in 1988 for some reason or another our military people had no proposals for its use. It became an unexpected gift with which no one knew what to do.

Many of our specialists expressed doubts about the future of the Energiya-Buran system, which from the very beginning was inferior to the similar American system: the design of the orbital ship itself was not thought through (absence of a propulsion engine), low efficiency of the fuel employed, lesser weight of the launched payload and inadequate booster reliability. But at that time no one heeded these doubts. Although, in addition to the protests, Soviet designers and engineers proposed a number of alternative projects, such as the "Spiral" aerospace system proposed by Gleb Lozino-Lozinskiy, the original orbital aircraft proposed by Vladimir Myasishchev and many others. The Soviet bureaucratic system was so wound up that it could not stop.

Construction of the Buran orbital ship began in 1976 and two years later the cosmonaut-test pilot detachment was formed in which among the 500 candidates there were only 9 fliers, for the most part from the Flight Research Institute (FRI). Igor Volk, HSU, after flight into space, was designated detachment commander, and the first group included the test pilots O. Kononenko, A. Levchenko, A. Shchukin, R. Stankyavichyus and the two military fliers I. Bachurin and A. Boroday. Intensive preparations for flight in the Buran began.

"Due to the impossibility of directly carrying out preliminary flight tests of the orbital ship itself," says Yuriy Shiranov, deputy chief of one of the Flight Research Institute divisions, "a unique method was devised for investigating the Buran glider and its systems. It included 'flights' on different kinds of simulating stands, flying laboratories (FL) and a full-size mockup of the manned ship—the BTS-002 (large transport aircraft).

Special flying laboratories based on Su-7, Su-17 and MiG-25 aircraft were constructed for training the crews and so that the test pilots could master engineless maneuvering and landing modes. However, these FL did not fully correspond to an analogue of the orbital ship and therefore new FL came to be designed on the basis of Tu-154 aircraft. The takeoff and landing weights of this liner and its dimensions were almost identical to the mass and dimensions of the orbital ship. In addition, the Tu-154 cabin was large enough to place the Buran control panel in it. Finally, it was possible to install the necessary telemetric and control-registry instruments in the body of the aircraft.

What was the nature of the BTS? This was a full-sized analogue of the Buran in which four gas turbine engines were installed only for making flights in the atmosphere. Outwardly it differed in no way from the orbital ship. It, like the Buran, has catapult seats and control panels. However, the cargo compartment held fuel tanks instead of the payload which was to be put into orbit. The first flight of the analogue was in November 1985. It carried Igor Volk and Rimas Stankyavichyus. The detachment was soon joined by Viktor Zabolotskiy, Magomed Tolboyev, Sergey Tresvyatskiy, Yuriy Sheffer, Ural Sultanov and Yuriy Prikhodko.

In addition to numerous flights, the test pilots had to study celestial mechanics, astrophysics and space navigation and had to participate in experiments for survival at sea, in the mountains, taiga and desert.

Unfortunately, despite the enormous expenditures on the training of Soviet cosmonaut-researchers, the program for implementing manned flights in the Energiya-Buran universal space transport system is now in doubt. It appears that neither the system itself nor the test pilots are necessary to anyone. The space detachment was a hostage of the Soviet system which created it. With its destruction it also ceased its active existence.

Representing Aerodynamic Moment in Problems of Mathematical Modeling of Rotational Motion of Artificial Earth Satellites

937Q0076A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 30 No 6, Nov-Dec 92 [manuscript submitted 15 Nov 91] pp 771-779

[Article by Ye. Yu. Zuyeva, M. M. Komarov, V. V. Sazonov; UDC 629.7]

[Abstract] A subroutine package for modeling three-dimensional objects—GEOMOD, developed at the Keldysh Institute of Applied Mathematics—is used to calculate the main vector and main moment of the aerodynamic-resistance forces acting on an arbitrarily shaped Earth satellite. The subroutines assume that the molecules of air colliding with the surface of the satellite have a perfectly inelastic impact and that the following formulas are valid: $\mathbf{F} = -\rho S |\mathbf{V}| \mathbf{V}$ and $\mathbf{M_O} = -\rho |\mathbf{V}| (\mathbf{D_O} \times \mathbf{V})$, where ρ and $(-\mathbf{V})$ are the density and velocity of the aerodynamic approach stream, $S = S(V)$ and $\mathbf{D_O} = \mathbf{D_O}(V)$ are the area and first moment of the geometric figure G, which is the projection of the outer shell of the satellite onto surface Π_V, which is perpendicular to **V**. Vector $\mathbf{D_O}$ lies in the plane Π_V and is computed relative to the projection onto Π_V of the reduction pole of the systems of aerodynamic-resistance forces, designated as O. The formulas assume that the satellite is motionless relative to the approach stream. If the largest dimension of the satellite does not exceed several dozen meters, the formulas can also be used if the angular velocity of the satellite is absolutely comparable to the angular velocity of the orbital motion. The researchers describe a technique for organizing and computerizing the calculations on the basis of computational geometry. The subroutines are written in Turbo Pascal for PCs. Figures 5, references 6: 3 Russian, 3 Western.

Rotational Motion of a Spacecraft With a Solar Stabilizer

937Q0076B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 30 No 6, Nov-Dec 92 [manuscript submitted 3 Jan 92] pp 780-790

[Article by V. V. Sidorenko; UDC 531.36]

[Abstract] After separation from the upper stage, a spacecraft is in a state of uncontrolled rotation. That rotation is usually brought under control with an active attitude-control system, but a passive system based on light pressure can also be used, i.e, a system that uses solar vanes that either absorb or reflect solar radiation. The researchers here examined the simplest of such systems—plates attached to the body of the spacecraft to present the form of a propeller. Averaging is employed to study the motion of the spacecraft during the period in which the rotation is first brought under control. The study is based on the following assumptions: (a) the exterior contours of the spacecraft and the solar stabilizer have an axis of symmetry; (b) the spacecraft's nutational oscillation damper is a balanced flywheel with an axial moment of inertia *I*, with the energy dissipated through a viscous-friction-type interaction of flywheel and spacecraft body described by the dissipative function $\Phi = (1/2)kO_d^2$, where *k* is the damping coefficient, O_d is the rate of rotation of the flywheel relative to the spacecraft body, and the amount of friction of is large; (c) the ellipsoid of inertia of the spacecraft with the flywheel is an ellipsoid of rotation, with the axis of symmetry coinciding with the axis of the geometric symmetry of the shell of the spacecraft; and (d) the solar vanes are *N* mirror-reflecting plates uniformly places at a distance *R* from the axis of symmetry of the spacecraft in a plane that is a distance *l* from the center of mass of the spacecraft. The orbit of the spacecraft is assumed to be circular heliocentric. The researchers conclude that with an evolution of motion close to slow precession, if $\lambda > 1$, the nutational oscillations attenuate quickly and set up a regular precession whose parameters change very slowly. If $\lambda < 1$, the oscillations grow quickly, and the motion moves away from that of regular precession. The propelling moment is found to have more of an influence on the variation in parameters describing fundamental regular precession. Figures 4, references 13: 10 Russian, 3 Western.

Dynamics of An In-Orbit Elastic Cable Tether Between Two Bodies

937Q0076C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 30 No 6, Nov-Dec 92 [manuscript submitted 5 May 91] pp 791-799

[Article by V. I. Gulyayev, S. G. Kravchenko, K. Ya. Golovatyuk, V. L. Koshkin; UDC 629.191]

[Abstract] In problems associated with the mathematical modeling of the dynamics of the relative motion of an orbital system of solids linked by a flexible cable, the system must be very long, which requires that the elastic and thermal variations of the cable be taken into consideration, because the relative motions it induces in the system are accompanied by additional effects that complicate the behavior of the system. The cable can be regarded as just tension, and the linkup it creates is a unilaterial constraint. Each time the cable linkup is engaged or disengaged, there is a change in the structure of the orbital system, which must also be taken into consideration in setting up a problem. When the cable is reeled in or out, the geometry of the masses of the system change considerably and the masses can move to new forms of motion. The work reported here studies certain applied aspects of the dynamics of cable systems, with attention focused on flexibility, unilaterality, and elasticity of the link, as well as thermal variation of the length of the cable when the system passes across the terminator boundary. A problem is posed in which a mechanical system of two bodies is linked by a flexible, extendable cable. The center of mass in the initial state moves in some orbit around an attracting center. The cable is stressed by forces of inertia and gravity, and a winch pays the cable out or pulls it in on one of the bodies. In studying the dynamics of the tether when the cable length changes, the researchers look at the

effect of the change in the geometry of the masses on the dynamics of the system's librational transition motions for the reeling in and out of a 2-mm-diameter cable with an EF of 61544 H. Analysis of the effect of the initial value of the angle φ between the cable and the direction of the current radius-vector of the center of mass relative to the attracting center on the dynamic behavior of the system showed that the pendulum behavior of the system is very sensitive to the variation in $\varphi(0)$ in the direction of its negative values and that when $\varphi(0) = -\pi/36$, the cable system flip-flops during the initial payout of cable and later begins to produce pendulum motions in the vicinity of $\varphi = -\pi$. Three types of motions with different initial conditions are examined: (a) with $t = 0$, the system is oriented along a local vertical, elastic oscillations are absent, and the cable is reeled in at a given rate and the lower body moves at the same rate; (b) with $t = 0$, the tether is in gravitationally stabilized equilibrium in the orbital system of coordinates, there are no elastic oscillations, and the lower body is immobile; and (c) with $t = 0$, the angle between the system and the current radius-vector is $\varphi(0) = \pi/12$, there are no elastic oscillations, and the cable is reeled in at a given rate, with the lower body moving at the same rate. Figures 4, 8 references (Russian).

Optimal Pulsed Orbital Transfers With Aerodynamic Maneuvers

937Q0076D Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 30 No 6, Nov-Dec 92 [manuscript submitted 26 Feb 91] pp 800-809

[Article by S. N. Kirpichnikov, A. N. Bobkova; UDC 531.55:521.1]

[Abstract] A problem involving optimization of fuel consumption is examined for orbital transfers that use aerodynamic maneuvers. The motion takes place in the central Newtonian field of a planet with an atmosphere. The aerodynamic maneuver is a passive pulsed reduction in velocity at the pericenter of the transfer orbit via braking of the spacecraft as it passes through the planetary atmosphere. The maneuver is performed at the boundary of the dense layers of the atmosphere at a distance R from the attraction center, where R is the radius of the planet, increased by the altitude of the dense atmospheric layers. The braking pulse is tangential, and its magnitude is chosen with the aid of small variations in the transfer orbit or by varying the length of the segment of motion with an open braking parachute. The boundary orbits are considered to be elliptical with the same direction, and the time of the motion is free. The researchers consider transfer between freely oriented boundary orbits and circular boundary orbits, transfer with aerodynamic maneuver between specific boundary orbits, and tangential transfer with aerodynamic maneuver between boundary orbits. Figures 3, references 11: 10 Russian, 1 Western.

Modeling the Dynamics of Electron Beams Injected Into Ionospheric Plasma

937Q0076E Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 30 No 6, Nov-Dec 92 [manuscript submitted 16 Dec 91] pp 810-815

[Article by G. D. Gefan, A. A. Trukhan; UDC 533.95:551.510]

[Abstract] Severe near-injector scattering of electrons that cannot be attributed to collisions of electrons with neutral or charged particles of plasma has been observed in a number of experiments involving injection of a beam of electrons with energies of E = 1-10 keV into ionospheric plasma. It has been surmised that a modulation instability of plasma that is a result of beam instability is responsible for the anomalous scattering. Based on that, the researchers here constructed a numerical model of the scattering and dynamics of injected electrons based on a given turbulence background whose level is determined by the balance of energy in the ionospheric plasma/electron beam system. Pitch-angle scattering of the electrons against a turbulent background is described by a term similar to the integral of Coulomb collisions. The results of the numerical solution of the kinetic equation of the injected electrons demonstrate that the turbulent background that comes about because of the modulation instability of the plasma may be the cause of the anomalous scattering. Calculations show that in relatively weak injections, even scattering of the beam on neutral particles can disrupt the driving conditions. Figures 4, references 8: 3 Russian, 5 Western.

Solar Cosmic Ray Flares and Large-Scale Structures of the Interplanetary Medium. Prediction of Solar Proton Events. II

937Q0076F Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 30 No 6, Nov-Dec 92 [manuscript submitted 9 Sep 91] pp 816-825

[Article by I. P. Shestopalov, V. V. Bengin, G. Ya. Kolesov, V. M. Petrov, P. I. Shavrin; UDC 537.591.4.574.83]

[Abstract] This paper extends the work of the earlier papers, showing that the existence of the fluxes of solar wind is associated with the presence of interplanetary fluxes of solar wind that are observed in Earth orbit long before the arrival of the flare disturbance. The existence of those fluxes is tied to active regions in which a flare takes place and that the structure of such fluxes is similar to that formed in the flare disturbance, i.e., the structure of the interplanetary space in the period of a solar flare is formed not only by the flare formations, but also by the high-velocity fluxes of solar wind; they are not directly connected to the flare itself. The source of the fluxes is the active region in which a flare occurs. The researchers point out that two processes take place during a flare period. The first process is linked to the appearance and evolution of active centers on the Sun and with the formation of

coronal formations and their ejection into interplanetary space. The second process is associated with the flare itself and with a series of phenomena that take place on the Sun and in space after the flare. Coronal matter are ejected and charged particles generated in each of the processes. The particle fluxes and spectra in the processes are different, but there is a link between them. During a flare, particle fluxes unrelated to the flare, plus fluxes existing before the flare, are added to the flux of particles generated by the process. Figures 5, references 10: 5 Russian, 5 Western.

Ice Clouds Over Martian Volcanos From Fobos Mission KRFM Experiment Data

937Q0098A Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 27 No 1, Jan-Feb 93 [manuscript submitted 26 Oct 92] pp 19-25

[Article by Ye. B. Petrova, Space Research Institute, Russian Academy of Sciences; UDC 523.41/43-852.2]

[Abstract] The white and blue clouds over elevated regions of Mars were observed in February and March 1989 during the FOBOS mission. When the Fobos-2 spacecraft passed over Tharsis, its KRFM spectrophotometer recorded a considerable increase in brightness in the UV and blue ranges of the spectrum. The observation track crossed Arsia Mons twice and Pavonis Mons once, and the measurements were done from the morning to evening limb in eight spectral intervals centered on 315 nm, 328 nm, 346 nm, 363 nm, 410 nm, 445 nm, 448 nm, and 550 nm, with an average spectral resolution of 10, in opposition. Spatial resolution was approximately 30 km. The author used a model of high-altitude clouds represented as a flat layer and consisting of transparent ice particles uniformly mixed with CO_2 gas to analyze the spectrophotometric measurements over Tharsis. She concluded that there are at least two possible models of the clouds over Tharsis. In the first, the clouds consist of fine ice particles with an effective radius of around 0.5 μ. Their optical density is about 0.2. The model's agreement with the experimental data was not very sensitive to the selection of a value of atmospheric pressure from 0.5 mb to 2 mb. Such clouds can be found over volcano peaks. The second model presents the clouds as ice particles with a larger effective radius (1 μ) and an optical density of 0.07-0.1. If those particles have a silicate nucleus, it is so small that it has no appreciable influence on the scattering properties of the particles. Clouds of such particles are found below the peaks of volcanos, at altitudes of about 15 km. The amount of ice contained in the clouds near the mountains is estimated at 3.5 x 10^{-6} g/cm^{-2} to 5.0 x 10^{-6} g/cm^{-2}. Figures 3, references 13: 7 Russian, 6 Western.

Dust Population of Halley's Comet From DUSMA Experiment Data

937Q0098B Moscow ASTRONOMICHESKIY VESTNIK in Russian Vol 27 No 1, Jan-Feb 93 [manuscript submitted 22 Oct 92] pp 45-70

[Article by J. A. Simpson, D. Rabinowitz, A. J. Tuzzolino, M. A. Perkins, L. V. Ksanformaliti, Enrico Fermi Institute, University of Chicago, Chicago, Ill.; Space Research Institute, Russian Academy of Sciences; UDC 523.64-1/-8]

[Abstract] Results are presented from the dust counter and mass analyzer (DUSMA) measurements made by the Vega-1 and -2 spacecraft during their 1986 encounter with Halley's Comet. The two spacecraft passed through the coma of the comet on 9 March 1986 and carried DUSMA detectors, which had a time-resolution of 3-4 μs, thereby enabling the detection of streams of particles with densities of up to 20 x 10^3 s^{-1}. Three components of the coma's dust population were identified: background particles, spiral ejections, and cluster groups. Mass spectra took the form of $m^{-0.6}$, but vary considerably around the coma. The spiral ejections were found to be linked to the position of certain long-lived sources on the surface of the nucleus. Based on the mass dispersion of the particles in the spiral ejections, the following terminal particle velocities: 0.40 km/s^{-1} for masses of 10^{-13} g to 5 x 10^{-11} g; 0.33 km/s^{-1} for 5 x 10^{-9} g to 1.6 x 10^{-9} g; and 0.30 km/s^{-1} for 1.6 x 10^{-9} to 4 x 10^{-8} g. Velocity dispersion corresponded to the calculated ratio of dust mass to gas mass, 0.15. The apex position for those masses lies at 40,000-60,000 km. The ratio of radiation acceleration to gravitational acceleration is 0.18. The mass spectra were found to have a value of |α| 0.60-0.70. Figures 19, references 27: 4 Russian, 23 Western.

'Progress' Plant in Samara to Develop 'Rus' Space Launcher

937Q0103A Moscow IZVESTIYA in Russian 24 Mar 93 First Edition p 5

[Article by B. Konovalov: "We're Building Rockets Like Before"; first paragraph is source introduction]

[Text] In Samara, the Central Specialized Design Bureau (TsSKB) has begun developing a new rocket, Rus. It is to be built by the Samara Progress plant.

The new rocket is to replace three series-produced launch vehicles—the Soyuz, the Vostok, and the Molniya—which are also manufactured by the Progress plant and account for the "lion's share" of our space launches.

Each of those rockets, which were developed on the basis of the legendary R-7 intercontinental missile created by Korolev's design bureau, performs its own job in lifting payloads to various orbits. Now it has been decided to make one standardized launch vehicle. The standardization will make it possible to take five types of engines and six types of rocket stages out of production.

The Rus rocket is equipped with a new control system that includes an onboard computer complex. Rus will also be able to perform a number of jobs that used to be handled by rockets built in Dnepropetrovsk.

Design-wise, it will be reminiscent of Korolev's R-7. Four "strap-ons" will be attached to a central unit. The third stage will be new, which, just because of that, will make it possible to increase the lift capability by 800 kg over the Soyuz launcher now being used. The fourth stage (the boost stage) will be a stage newly developed by the Lavochkin NPO, which make it possible to confidently handle tasks associated with the mid-range and high orbits.

The Rus rocket will enable launches both from Plesetsk and from Baykonur. After it is on line, manned spacecraft, as well as satellites, can be launched from the Russian cosmodrome.

The increase in power-engineering characteristics make it possible to move to an orbital inclination of 65° for manned spacecraft from the 51° being used right now and to abandon two launch paths on which spent parts fall on land.

Rus will be developed and produced in its entirety by Russian organizations. The flight tests of the new rocket are to begin in 1996.

The Samara Progress plant, however, fears that it may not last that long. It has come under hard times. For the third time already in a short period of time, the state has drastically changed the nature of its production, virtually scrapping its former inventories. Initially, when the development of a domestic rocket-building sector arose abruptly as an important issue, the aviation plant, which had produced long-range bombers, had to be feverishly converted into a rocket-building plant. Then, after the death of S. P. Korolev, the production of the N-1 lunar rockets, which had been set into motion with tremendous difficulty, was hastily shut down. Now production of the Energiya rockets, the largest rockets in the world—production that took an even greater effort—is in mothballs.

A plant is a system with more inertia, a larger system than a design bureau, and it's more difficult to retool. In order to feel itself soundly in the market element, Progress needs massive civilian-oriented production. One possibility is the mass production of high-quality kitchen ovens licensed by the prominent firm Sanyo with Japanese equipment. A second well-studied possibility is to set up production of cars for railroad rolling stock and electric trains.

Russia needs the Rus rockets, there's no doubt about that. And it also needs the family of magnificent satellites created by the TsSKB. For that reason, the TsSKB and the Progress plant are vitally interested in conversion, and they need help to pull it off. Right now, however, there is no help.

'Mini-Energiya' Launch System Proposed

937Q0101A Moscow PRIRODA in Russian No 3, Mar 92 pp 14-15

[Article by G. A. Buldyayev, candidate of technical sciences, docent, Training and Retraining Institute, Rosobshchemash Corporation: "Humanization Problems in Cosmonautics"]

[Excerpt] [passage omitted]

Organization of Joint Enterprises

Different organizations are now vigorously carrying out work in this direction. The Komposit NPO, for example, has already organized joint enterprises with Germany and Italy for the production of the latest materials. Other enterprises also are seeking foreign partners. This is a completely new business for defense enterprises and therefore there must be strict adherence to ecological safety when locating harmful production plants in the territory of the country and also when determining the list of materials, fuels, technologies and manufactured items not subject to export abroad, etc.

For example, even today, in collaboration with the CNES (French National Space Research Center), it is possible to organize a company (consortium) for the development, construction and operation of a space system for the vertical launching of the "Mini-Energiya-Hermes." In such a case Soviet enterprises could develop and construct the partially multiply reuseable "Mini-Energiya" booster (instead of the planned singly useable Ariane-5 booster), whereas the French partners could construct the Hermes manned orbital ship. Since only passive mechanical couplings between the booster and ship are contemplated (there will be no

pneumohydraulic and electrical connections), it would be possible for this work to be done at a high level by each side independently of one another.

It is planned that the first stage of the booster be designed on the basis of the Buran glider unit and it will be a winged unmanned completely multiply reuseable rocket stage. A single engine with the first stage from the Energiya booster is to be mounted in its rear part. After separation from the second stage it is rotated and performs a cruising flight by means of turbojet engines and lands as an aircraft in an automatic mode at an airfield near the Kourou launch site (French Guiana). The second stage of the booster is constructed on the basis of the oxygen-hydrogen propulsion units designed for the Energiya booster. It will carry one engine from the second stage of the Energiya booster. After completing its mission this stage enters the dense layers of the atmosphere, is partially destroyed and falls into the ocean. The orbital stage is mounted atop the second stage.

The "Mini-Energiya" will be a universal booster, which will make it possible to ensure launchings of commercial payloads in both transport and manned variants. In the transport variant as the orbital stage it will be possible to use a load whose total mass exceeds the payload mass launched by the Proton booster. In the manned variant of the booster the orbital stage can be a Hermes orbital ship in whose inner compartment it will be possible to carry several payloads with a total mass close to the payload mass put into orbit by the Soyuz booster. In the transport variant the booster will make it possible to launch commercial payloads into any geocentric orbits, including geostationary. In the manned variant the booster will make it possible to launch commercial payloads into any geocentric orbits, including geostationary. In the manned variant the booster will ensure not only the launching of commercial payloads into circumterrestrial orbits, but also the possibility of performing transport-technical servicing (diagnosis, repair, refueling, etc.) of satellites and orbital stations in these orbits.

In comparison with the Ariane-5, the "Mini-Energiya" will have a whole series of advantages:

—it will require lesser total (during the entire "life" of the booster) economic expenditures due to the lower specific cost of each launching;

—higher "social" characteristics (due to its partial "multiple reuseability"); reduction of expenditures on the construction of the stages (only the second stage is only useable once), and the working stages, earlier employed for this, after passing through appropriate modification, will be diverted to more diversified and creative work in servicing (diagnosis, repair, etc.) of the multiply reuseable first stage;

—the concept of "alienated lands" will be eliminated because the winged first stage, returning independently to the launching site, does not require the alienation of additional lands (or sea areas) and the second stage, used only once, falls into the ocean;

—the winged first stage will make possible launchings in all azimuths, which in the long run will ensure the more precise launching of commercial payloads to intended points in orbits with lesser expenditures;

—the presence aboard of relatively pure fuel (kerosene and liquid hydrogen) not only will ensure absence of pollution of land and sea areas near the launching complexes, but also will substantially reduce the degree of destruction of the Earth's ozone layer (the Ariane-5 will annihilate 400-800 times more ozone).

Thus, the "Mini-Energiya" booster, in comparison with the Ariane-5 booster, will have more acceptable energy, economic, ecological and other characteristics. Today the energy characteristics are the most important: the design of the Hermes ship already has several times been reexamined for the purpose of reducing its mass. When using the "Mini-Energiya" booster this problem will not exist.

Recently in the open press there has been discussion of an international project for development of the "Molniya" aerospace system with horizontal launching based on the AN-225 ("Mriya") aircraft. To be sure, for known reasons, many projects, born within the walls of the "defense people," still remain unpublished. But already in 1979 the author proposed to V. P. Glushko, the former general designer of the Energiya NPO, the concept of a rocket-space system with vertical launching on the basis of the "Mini-Energiya" booster. Despite the fact that more than a few years have passed, it has not become technically outdated. Moreover, even in comparison with the "Molniya" aerospace system it has superior energy, economic and ecological characteristics. Without doubt the future belongs to single-stage aerospace systems with horizontal launching. But this is in the relatively distant future. And for the time being a rocket-space system with vertical launching on the basis of the "Mini-Energiya" booster remains optimal. It can be constructed relatively rapidly and with minimum expenditures due to the use of the already available infrastructure of the Energiya-Buran rocket-space complex and the work cooperation which is taking shape in our country. Incidentally, there is no other country, including the United States, which is today capable of constructing such a booster.

In conclusion I would like to express the hope that what was said above not only will help in formulating practical recommendations on carrying out conversion in the national rocket-space industry, but also will exert an influence on the development of the scientific and technical progress humanization process in the country.

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NPO Molniya Designer Advocates Hydrocarbon-Fueled Aerospace Plane

937Q0095A Moscow ROSSIYA in Russian No 9, 2 Mar 93 p 11

[Article by Vitaliy Natalich, chief designer, Molniya NPO: "Space Plane"]

[Text] The trend in improvement of space transport vehicles is evident: development of aerospace systems using more economical winged flightcraft for putting loads of about five tons into space.

Among the promising projects for multipurpose aerospace planes for repeated use are the MAKS "VTB+OS," Interim Hotol, Hotol M... Those which correspond to a set of criteria for more complete satisfaction of the requirements specifications have the best chances for realization.

The projects for an aerospace plane provide that liquid hydrogen is to be used as fuel and this considerably limits the possibility of their use for a number of reasons, in particular, due to the low reliability and safety parameters. The lack of experience in operating aerospace systems based on liquid hydrogen makes the axiomatic assertions concerning their priority questionable. A technical director who is an adherent of use of hydrogen fuel, to be sure, can boldly design the world's lightest fuel tank with the most complex aerodynamic appearance and technical use. But visualize the psychological state of the crew of the MAKS system or the AN-225-Interim-Hotol, having aboard a "hydrogen bomb" ready to detonate with the slightest failure in integrity of the tank filled with liquid hydrogen. It is known that in a mixture with air a detonation occurs in a wide range (from 4 to 75 percent) of hydrogen concentration.

However, the need for reliable and inexpensive space transport vehicles remains timely.

A group of specialists, after validating the possibility of developing a practical space plane, developed an alternative project for the "Promotey" aerospace plane operating on hydrocarbon fuel. It most fully ensures the requirements specifications, differing fundamentally from those mentioned above. In computing the ballistics, strength, engine characteristics, etc. use was made of well-known methods and the assumptions were based on real and statistical data with allowance for the attained technical level.

A multisided analysis of different conceptions of aerospace planes with respect to different problems indicated that relative to flightcraft using hydrogen fuel an aerospace plane based on hydrocarbon fuel, having a minimum mass and size, as a result of the great fuel density, in combination with lighter new-generation artificial earth satellites, is preferable in the immediate future because it has advantages with respect to all criteria without exception: economic, technical, commercial, operational, technological, efficiency in use, reliability and safety, time required for development, etc.

It must not be forgotten that attempts to use hydrogen fuel in aviation have demonstrated its unsoundness. Calculations of the technical-economic indices (in 1990 prices) confirms that with current world prices for the launching of a unit mass of payload the expenditures on developing aerospace systems with aerospace planes operating on hydrocarbon fuel with 40 launchings annually will pay for themselves in two years and with an improvement in operational qualities and with an increase in the intensity of launchings to 80 annually it will be possible to count on a profit of 13.8 billion dollars in a five-year period.

The savings in comparison with the Soyuz booster with the Progress spacecraft will be 15.3 billion rubles. In this case one aircraft carrier and 4 aerospace aircraft will ensure the launching of an equivalent payload corresponding to 800 Soyuz boosters with Progress spacecraft.

In addition, aerospace systems with aerospace aircraft based on hydrocarbon fuel will make possible a considerable saving of metal, fuel, alienated lands and other resources which will become increasingly more expensive.

A lag in the beginning of development work on aerospace planes with the financing of nonpriority work and launchings of boosters with the Progress spacecraft will result in annual irretrievable losses of 0.6 billion rubles or 1.6 million rubles per day.

The changes which are transpiring make it necessary in essence to reformulate Russian policy in the field of use of circumterrestrial space and to determine the priority directions in development work in this field.

The following must be taken into account in this connection:

1. The launching of a considerable number of boosters (in the numbers earlier planned in the USSR space activity program for 1996-2010) with a payload similar to aerospace planes is to be assigned to Ukrainian enterprises.

2. The Baykonur cosmodrome, handling a considerable percentage of the launchings of USSR boosters, is now abroad.

3. The economic situation now prevalent in the Russian Federation makes it necessary to reduce the level of financing of space programs, but at the same time it is necessary to save the aerospace industry from total destruction and to ensure that many existing production facilities associated with space will be kept busy.

Under these conditions the proposed concept of an aerospace aircraft is the sole really promising development of practical Russian cosmonautics in the near future, to wit:

1. The production of the aerospace system is situated in the territory of the Russian Federation.

2. In the territory of Russia there is an adequate number of airfields as required for the basing of aerospace systems.

3. An infrastructure (production, stand base, etc.) necessary for the production of liquid-fueled rocket engines based on hydrocarbon fuel, aerospace aircraft, equipment, etc., has been organized in Russia.

4. Russia has personnel having invaluable practical experience in the development, production and operation of such equipment.

5. The characteristics of the proposed aerospace plane are based on a technological level already attained in Russia.

6. There is work which has already been initiated on development of multiply useable orbital vehicles, on development of new construction materials and more perfect hydrocarbon fuels with improved energy and operational characteristics.

7. The times required for development work, volumes of financing and technical risk are minimal in comparison with other concepts.

In generalizing what has been stated above, it must be noted that with competent management in this field and with a correct distribution of financial resources (governmental and private firms) Russia has a unique possibility for occupying a leading position in the field of inexpensive and reliable space transport vehicles for the delivery of payloads into circumterrestrial orbit and its realization in the form of a specific political and economic advantage.

Advantages of 'MAKS' Air-Launched Spaceplane

937Q0060A Moscow IZVESTIYA in Russian 11 Jan 93 Morning Edition p 6

[Sergey Leskov, IZVESTIYA correspondent: "The 'MAKS' Can Carry Us From Moscow to New York in 1 ½ Hours"; the first sentence is an introduction]

[Text] There is a new space system which is affording rich future possibilities in many fields.

Cosmonautics is considered a field of applicability of the leading advances in science and technology. But what could be said of progress in the automobile industry if our roads were still strewn with tanklike Pobedas [postwar make of Russian automobile]? Meanwhile the overwhelming majority of space systems are being put into orbit by means of boosters already developed in the Korolev era...

New systems must be developed taking into account that 80 percent of the payloads have a mass about 8 tons. However the load-lifting capacity of the Soyuz, Proton and the American Shuttle is two or three times greater, which makes them similar to powerful locomotives pulling empty cars. Due to the lack of suitable loads the Buran and the Energiya superbooster have sat idle on the ground.

During recent decades in all well-developed countries without exception attempts have been made to construct light multiply useable space aircraft. Quite a bit has been written concerning the Saenger, Hotol, Hermes, NASP and Hope systems and almost nothing about the Russian "Maks" project, which is being developed at the Molniya NPO [Scientific Production Association] under the direction of G. Lozino-Lozinskiy, one of the main ideologists and developers of the Buran. After the curtain of supersecrecy was removed from the Molniya NPO, Western specialists visited here. It is possible to cite many references to the key foreign scientists who have been forced to acknowledge that the Russian "Maks" has outpaced similar Western developments by 6-8 years.

The "Maks" system is an An-225 ("Mriya") heavy transport aircraft on which is mounted a 27-ton orbital aircraft with a suspended tank for 200 tons of three-component fuel (hydrogen, oxygen, kerosene). The "Mriya" departs from the orbital aircraft at an altitude of 10 km and at a 100-km altitude the fuel tank is shot off into the ocean. The "Maks" load-lifting capacity is 8.5-9.5 tons.

The "Maks" is noteworthy for still another reason. Whereas even Baykonur retains its importance for the CIS, the minimum orbital inclination of our satellites to the equator is, even now, 51°. For the United States this inclination is 28°, for France it is 7°. (For this reason, incidentally, the Buran never will be able to enter the Shuttle orbit, but the American shuttle can, without difficulty, pass into the Russian orbit). The northern, and therefore the disadvantageous location of our test ranges, results in enormous energy losses during the launching of satellites. The "Maks" mobile launching facility eliminates this problem and the "Mriya" will deliver the orbital aircraft to the most advantageous launching point. The "Maks" may therefore be irreplaceable for organizing global satellite communication systems. But after some time, with a strengthening of reliability, also for suborbital passenger flights, when a flight from Moscow to New York will take 1.5-2 hours.

The light space taxi has no competitors when returning from orbital stations different materials, which, as specialists hope, even in the immediate future will begin to be produced by space factories under weightlessness conditions.

The "Maks" is characterized by many advantages, a depth and technical perfection of the system, as well as the availability of the already finalized "Mriya" aircraft-carrier, has impelled British specialists, running into difficulties with their Hotol, to the idea of a joint project. In addition, British Aerospace has turned to the European Space Agency, which for three years has held up

work on the Hermes, with a proposal on financing a Russian-European space aircraft on the basis of the "Maks." Specialists feel that not more than six years should pass from the moment of onset of experimental-design work to the first flight of the "Maks."

Project Participants Describe N-1 Moon Rocket Program

937Q0034A Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 9, Sep 92 pp 34-37

[Article by R. Dolgopyatov, B. Dorofeyev, S. Kryukov, under the rubric "At the Readers' Request": "The N-1 Project"; first paragraph is source introduction; paragraphs excerpted from accident commission reports are in italics]

[Text] The authors of the article presented here to the readers took part in the work associated with the N-1 project in a direct fashion. For example, Cand. Tech. Sci. Boris Arkadyevich Dorofeyev was deputy chief designer at the time and technical director of the experimental development of rocket complexes. From 1972 until the halt of the work on that research, he performed the duties of the chief designer of the N-1 rocket. Renald Dmitriyevich Dolgopyatov was a design group head and was one of the principal designers and layout people for the rocket from the first days of development to the closing of the operations. Dr. Tech. Sci. Sergey Sergeyevich Kryukov was the deputy chief designer of OKB-1 [Experimental Design Bureau 1] and the director of the theoretical design operations associated with the creation of the rocket.

In the late 1950s, OKB-1 was doing work on military-related missiles, as well as on space rockets and vehicles. The third and fourth stages were being developed for the R-7 rocket, the principal space launcher; the Molniya and Zenit satellites were being designed and tested, as were the unmanned probes for flights to the Moon, Venus, and Mars; and preparations were under way for manned flights into space.

But would they be able to send a man on an interplanetary flight and put a manned science base/station into orbit? How could those dreams be implemented? Without a new, superheavy launch vehicle, it would be impossible. And the group headed by Sergey Pavlovich Korolev began developing just such a rocket, called the N-1. The work was done in a subdivision in which the design and research departments and the departments for propulsion systems were concentrated, which made it possible to do the design in an integral fashion. Since the R-7 had already been aloft, it was natural to want to use its configuration, even though, after the number of sections and the dimensions had been increased, everyone understood that such a move was not entirely sensible from the standpoint of maximum weight-related efficiency. On the other hand, a configuration with a cross-sectional division of stages seemed more advanced to us. At the time, the R-9 was under development (one stands at the entrance to the Museum of Armed Forces), so we looked over its configuration, too.

It must be said that Sergey Pavlovich [Korolev] gave his designers complete freedom at this stage of the design, although he did take part in discussing the pros and cons of a given configuration. In the process, he recommended involving designers, technicians, and developers of rocket systems and ground equipment in the work and using their experience for conducting an in-depth study of specific questions and for reducing the number of "critics" we would run up against in subsequent work. That way, the component manufacturers would know that their ideas had been taken into consideration from the very beginning of the design process.

Rather broad ranges were set for the initial weights of the rockets (1000-2000 tons) and their payloads (40-80 tons). The creation of that kind of rocket would make it possible to solve a number of defense-related questions associated with the exploration of near-Earth space, create a global system of space-based communications and weather forecasting, and begin a study of the Moon and the planets nearest the Earth.

Estimates showed that most of those tasks could be done with a launch vehicle that put a payload of 70-100 tons into a circular orbit 300 km high. And those very requirements were included in the 1960 governmental decree and formed the basis of the development of the preliminary design.

When the configuration of the launch vehicle was being chosen, it was determined that a configuration with a cross-sectional division of stages and with single fuel tanks on each stages would more fully satisfy the requirements for maximum weight-related efficiency, reliability, and producibility.

The next stage of the design involved choosing the fuel components. That question was particularly important, since various points of view existed on the use of high-boiling-point or low-boiling-point (cryogenic) components for that rocket. A comprehensive assessment was made of booster specifications, operational features, startup and stability of engine processes, availability of test-stands, cost, toxicity, and a number of other properties of various substances. As a result, a vapor of kerosene and liquid oxygen—nontoxic, extremely inexpensive, and well-established as something under production—was chosen.

Unfortunately, V. Glushko, the chief designer of engines, didn't agree with that. He refused to participate any further in the development of the N-1. So the experimental design bureau of aviation engines, headed by Chief Designer N. Kuznetsov, was enlisted to develop a liquid-propellant rocket engine [LPRE].

It must be said that participating in the development of that rocket complex were nearly a thousand enterprises from various departments working under the technical direction of rocket-complex chief designer S. Korolev's

OKB-1, engine chief designer N. Kuznetsov's OKB-276, control-system chief designer N. Pilyugin's Automatic Instruments Scientific Research Institute (NIIAP), radio-systems chief designer M. Ryazanskiy's Scientific Research Institute NIIKP [not further expanded], gyroscopic-instruments chief designer V. Kuznetsov's Problems of Mechanics Scientific Research Institute NIIPM, and launch-complex chief designer V. Barmin's GSKB [not further expanded] Spetsmash. Designer oversight of the manufacture of the rocket at the manufacturing plants was done by the Kuybyshev affiliate of OKB-1, under the direction of D. Kozlov. After Korolev's death, OKB-1, which came to be called TsKBEM [Central Design Bureau Energomash], was headed by V. Mishin.

The preliminary design resulted in the choice of a three-stage rocket with a launch weight of 2,200 tons and 24 engines with a thrust of 150 tons each (on the first stage); the rocket was capable of putting a 75-ton payload into artificial Earth satellite orbit.

Structurally, the rocket had an exterior shell, inside of which were fuel tanks, engines, and other systems. The stages were linked to each other with connecting trusses, which enabled the gases to exit freely as the next stage's engines started up. The rocket's sections were not transportable, which is why the plants manufactured individual parts that could be shipped; the welding of the tanks and the assembly of the sections and of the rocket as a whole were done in the assembly-and-testing building at Baykonur.

The creation of a series of rockets was planned with the N-1 as the base model: the N-11, which would be based on the second, third, and fourth stages and would have a launch weight of 700 tons and a payload of 20 tons; and the N-111, which would be based on the third and fourth stages and would have a launch weight of 200 tons and a payload of five tons. The preliminary design, developed with the assistance of the component manufacturers, used the latest achievements of domestic science, machine building, cryogenic technology, and machining technology. In addition to that, the design required that industry strengthen production aspects considerably; reduce the production tolerances with regard to the physical and geometric characteristics of materials and component articles; create lightweight, strong, heat-resistant materials, etc. According to the design, the multiengine propulsion system would, for the first time in the history of rocket building, take a payload into orbit even if two pairs of engines switched off accidentally. That was the first tip of the hat to allowance for contingency situations in the development of that hardware.

The preliminary design was finished in 1962, and the primary set of design documentation, by March 1964. The flight-design tests were slated to get under way in 1965. But the organizational measures proposed in the design to ensure on-time flight tests were not backed up by resources or financing. And even the nest of tasks to be performed by the N-1 had not yet been clearly outlined, and the payload versions had not been designed.

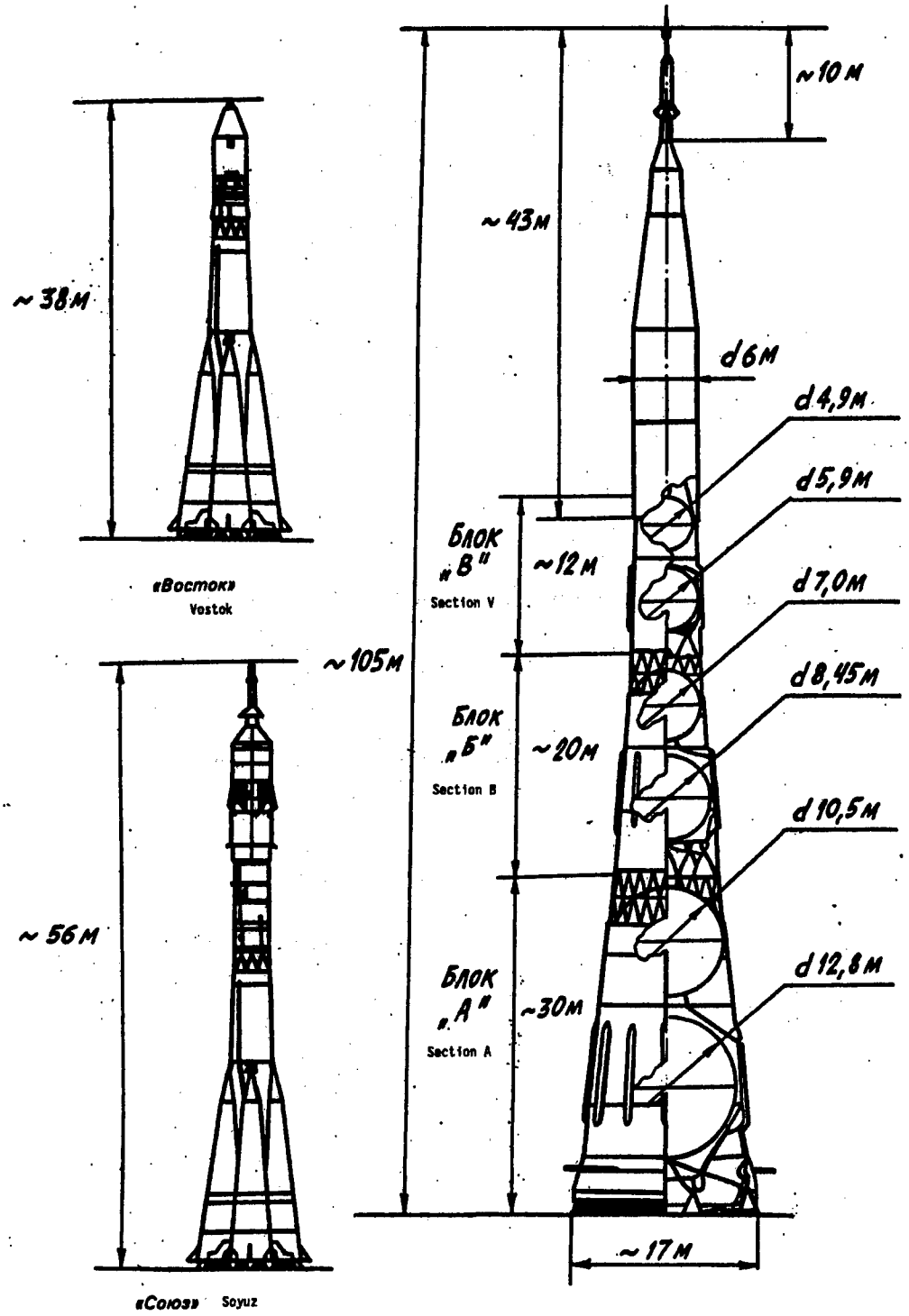
It is interesting that the landing of a man on the Moon was at first only third on the list of our priorities. But the prestige of sending cosmonauts to the Moon and the competition with the United States, which by that time was already working on the Saturn-Apollo program, put that objective at the head of all the work done on the N-1. A decree marking the beginning of such work came out in the summer of 1964.

Research on the version of the lunar rocket complex that would send two men into an artificial lunar orbit, land one of them on the lunar surface and return him to lunar satellite orbit, and then return both men to Earth indicated that the payload in artificial Earth satellite orbit would have to be 95-100 tons. For that reason, attempts were made to find solutions that would enable such a payload, without a radical redesign of the booster's structure. Of those solutions, the principals solutions were as follows: lower the altitude of orbit to 220 km from 300, change the launch azimuth, mount six additional engines in the central part of the bottom of the first stage, increase the mass of the fuel with inserts in the equatorial part of the tanks, lower the propellant and oxidizer temperatures, plus a number of other structural proposals slated for realization with rocket No 7. All that made it possible to raise the weight of the payload to 93.5-95 tons, with an increase in launch weight to 2,750 tons.

By that time, the mission profile and the fundamental payload configuration had been chosen. The N1-L3 aerospace complex was to perform a mission to the Moon.

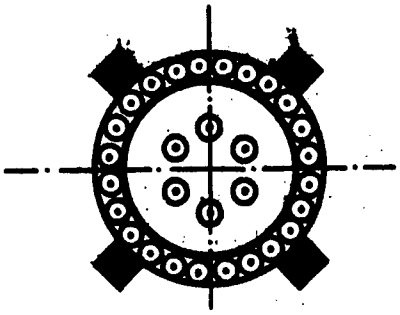
The work associated with the development of the booster was broad. For example, to assess local strength, more than 35 full-sized experimental assemblies of the most intricate, heavily loaded elements of the rocket's airframe were developed and tested. At the same time, research got under way on dynamic and aerodynamic characteristics on models, and the results of that research formed the basis of the design of the airframe structure and made it possible to begin developing algorithms for controlling the rocket in flight on models of analog-digital complexes of the OKB, NIIAP, Problems of Mechanics Institute [IPM], and other organizations. At the stage of the design-related research on the development of sustainer engines in 1962-1963, despite the lack of any experience and despite its being far removed from the test stands, N. Kuznetsov's OKB solved problems associated with the fundamental functioning of the engines and their assemblies.

Underlying the development of strength was the principal of testing individual sections of the structure for all cases of loading. The test stands needed for that were built in 1967.

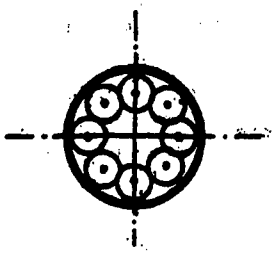


Technical specifications for the N-1 booster:

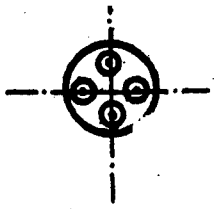
overall length (m) - 105;
length without payload (m) - 65;
maximum diameter (m) - 17;
number of stages - 3;
launch weight (tons) - 2,700;
payload mass in parking orbit (tons) - 95;
propulsion-system thrust (tons),
(first stage) - 4,620 ,
(second stage) - 1,430 ,
(third stage) - 164



ДУ блока «А»
Section A propulsion system



ДУ блока «Б»
Section B propulsion system



ДУ блока «В»
Section V propulsion system

A new problem involved the protection of the bottom part of the rocket from the thermal and mechanical effects of the exhaust jets of the liquid-fuel-engine array. Since the dimensions of the bottom of the first stage were so big, the proper choice of material and its thickness was extremely important if acceptable weight values were to be produced. The development of thermal protection materials and the technology for manufacturing them consisted in testing various samples of thermal-protection coatings for heatup on one side, with simultaneous vibrational loading, within a preassigned program and subsequent testing in the context of fire stand tests. The flight of rocket No 7 confirmed the high quality of the thermal protection.

The determination of the dynamic characteristics of the assemblies and of the rocket as a whole was done on special stands, as well as on rocket No 1M1.

The correctness of the determination of the design dynamic configuration was confirmed with the flights of rockets Nos 3, 6, and 7.

The studies of the aero- and gas-dynamic processes were done in wind and gas tunnels, in an altitude chamber, and on an actual model of the launch structure and the rocket and were refined in the flight tests. For example, the experiments performed after the flight of rocket No 6 on 27 June 1971, when it lost roll stability as a result of a large moment that the vernier gas nozzles couldn't handle, confirmed the hypothesis that the nature of the appearance of a roll moment that had not been considered before stemmed from a feature of the gas dynamics of the bottom current pattern and from the size of the bottom of the first stage.

At the end of 1963, N. Kuznetsov's OKB began final design tests of the sustainer engines, and in October through December 1967, the engines went through interdepartmental tests.

The quality of those articles was assessed with an engine-efficiency control system in which articles chosen by the client from a batch of engines submitted were subjected to fire tests, whereas the rest merely went through a "cold" check. But full-scale tests of rockets Nos 3 and 5 showed the engines of the first stage to be insufficiently reliable and the adopted system of control to be ineffective. So in July of 1970, N. Kuznetsov's OKB began using those engines to create fundamentally new engines for that time frame of multiple-firing LPRE and with a considerably longer service life. The interdepartmental tests of those engines were completed in September 1972 for the first and second stages and in November 1973 for the engines of the third stage.

Beginning with rocket No 7, vernier engines redeveloped in TsKBEM were installed, to ensure the rocket's roll stabilization. In August 1972, they underwent interdepartmental tests, and later they were perfected in flight.

The selection of a multiengine rocket-section configuration, each section with its own fuel tank, gave each propulsion system hydraulic independence and made each system autonomous; it also made it possible to begin integrated, final ground tests of the propulsion systems of the first and second stages together with engines in various combinations of adverse factors on the EU-28 and EU-29 test units, created in September 1967 on the stand at N. Kuznetsov's OKB. The final stage of the stand testing of the propulsion systems consisted in the tests of the rocket sections on the NIIkhimmash [not further expanded] rocket firing stand, which had been created earlier to do final testing of the R-7 and then had been redesigned to test all except the first rocket section of the stages of the N1-L3 complex. But it must be noted that the principle of the design similarity of the sections that was used in the creation of the rocket made it possible to extrapolate the firing-stand test results of the second-stage section based on the testing of solitary propulsion systems to the first-stage section, too. The correctness of that solution was confirmed with flight tests.

A mockup engineering rocket and nose section were used to effect the integrated final ground testing of the N1-L3 as a whole, including the final testing of the launch structures and the procedures for prelaunch preparations. And since a great deal of the tests in the creation of the N1-L3 were full-scale tests, the information they provided acquired especial significance. That is why that rocket was also used as a comprehensive stand for testing measurement systems and services. It "lasted" from 1966 to the first quarter of 1975, over which period of time it underwent four modifications. Based on the results of the final ground testing, rocket No 3 was released for flight tests.

In all, there were four flight tests. The first launch took place on 21 February 1969; three months before that, the American astronauts Borman, Lovell, and Anders had performed a flyby of the Moon aboard Apollo 8. The rocket flew along the design trajectory for 68.67 seconds, after which a fire in the engine compartment of the first stage resulted in the cutoff of the sustainer LPREs. Each successive launch was performed only after painstaking analysis of the telemetry, analysis of the material defects, and execution of measures to eliminate the problems.

On 3 July 1969, during the second launch, the failure of rocket No 5 resulted in the destruction of the launch complex. The flight tests of the N1-L3 were becoming protracted—time was needed to ascertain the causes of the failures and to take measures to correct them. As we know, on 24 July of that same year, the people of this Earth greeted Armstrong, Aldrin, and Collins—the Apollo 11 crew, which had stepped onto the surface of the Moon on 21 July.

Political interest in our lunar program subsided. The question arose of whether to raise the level of the scientific-technical objectives of the program for exploring the Moon and of the further use of N1-L3. Still focused on the final testing of the N-1, TsKBEM, together with the component manufacturers, worked up the "Technical Proposals for the Creation of the N1-L3m Complex"—proposals that matched the USSR Academy of Sciences's "Technical Objectives." That modification would have enabled, through the launches of two rockets with new lunar sections, a lengthy mission to the Moon and would have provided for the emergency return of the crew to Earth.

The proposals called for accelerating the final testing of the N-1 and for creating a fourth-stage oxygen-hydrogen booster section.

On 27 July 1971, during the third launch, rocket No 6 lost its roll stability, and after the beginning of the destruction of the linkup of the third stage and the nose section at 50.1 seconds, the engines of the first stage were cut off.

On 23 November 1972, there was a fourth launch. Rocket No 7 lifted off. It had undergone extensive changes that were aimed at increasing the mass of the payload being carried and at eliminating shortcomings identified in previous tests. The area of the bottom of the first stage had been reduced, its thermal-protection characteristics and the thermal insulation of the tanks improved, and the mass of the gas-supply assemblies reduced. Flight control was performed by an onboard computer from commands issued by a gyrostabilized platform that had been developed by the NIIAP. Other improvements had also been made. Vernier engines and active and passive fire-extinguisher systems had been added to the propulsion systems, and improvements to, for example, the mechanical and thermal protection of the instruments and the onboard cable system had been implemented. The measurement systems had been beefed up with miniature radio-telemetry gear developed by OKB at MEI [not further expanded] (Chief Designer A. Bogomolov). That made it possible to obtain information from roughly 700 newly mounted sensors (in all, there were more than 13,000 sensors on that rocket).

If, as we recall, interdepartmental tests had been performed for new engines of the first and second stages in September 1972, then why was rocket No 7 launched with old engines? In point of fact, certain ministry heads were of the opinion that it should be mothballed. But such a decision would have led to a further delay in the creation of the launch vehicle of at least two and a half years. And while the new engines were being manufactured and stand tests of the sections were being performed, the launch of rocket No 7 would be used to check out the dynamics of the flight control with the new vernier engines and the essentially new control system, as well as check out many other designs. After a number of discussions, the State Commission decided to go through with the launch. The rocket flew with no problems for 106.93 seconds, but, seven seconds before the assigned time for the cutoff of the first stage, engine No 4 was destroyed almost instantaneously, which lead to the destruction of the rocket.

From the Documents and Conclusions Issued by the Accident Investigation Commissions

Rocket No 3. At 0.37 seconds before the triggering of the liftoff switches [kontakty podyema], a spurious command from the KORD system shut off engine No 12 and then, according to the logic, the opposite engine, No 12. Until 68.67 seconds, the flight had been proceeding along the assigned trajectory, and, with the exception of engine No 12, the engines had been operating normally. The vibrational loads on its gas generator during the launch reached 450 g (on engines Nos 1 and 3, they did not exceed 150 g); at 5.5 seconds, a line for measuring the gas pressure behind the turbine ruptured; at 8 seconds, the regime began to drop spontaneously; at 23.3 seconds, the line for measuring the gas pressure in front of the gas-generator injectors ruptured.

At 54.5 seconds, a sharp rise in temperature was recorded in the vicinity of engines Nos 3, 21, 24, 23, and 22.

At 68.67 seconds, the KORD system issued a command to shut off all engines in the fluctuation channel because of a short in the 1000 Hz DC and AC circuits.

Rocket No 5. The failure of engine No 8 upon entry into the main stage (0.22 seconds before the triggering of the liftoff switches).

In the time interval between -0.2 second and +0.25 second, the following happened: (a) the rocket's airframe was subjected to pulsed loading; (b) there was a sharp rise in temperature in the vicinity of engines Nos 7, 8, and 9; (c) the telemetry equipment of engines Nos 8 and 9 failed.

At 0.6 second, the KORD system issued a command to shut off engines Nos 7, 8, 19, and 20.

At 8.76 seconds, the KORD system shut down engine No 21 (and opposing engine No 9).

At 9.3 seconds, the power-supply circuits malfunctioned.

At 10.15 seconds, all engines, except No 18, were shut off.

At 14.5 seconds, the emergency rescue system for the descent vehicle mockup triggered.

At 23 seconds, the rocket fell back onto the launch structure.

The cause of the failure of the engine was the ignition of the oxidizer pump and its destruction.

Rocket No 6. All the engines worked normally. From the moment the flight started, roll stabilization of the rocket proceeded improperly. The roll error grew steadily and was 14° by 14.5 seconds, despite the counteraction by the vernier nozzles, which, at 7.5 seconds, had hit the mechanical stops (45 °).

At 39 seconds, the gyro instruments ceased working normally, and for the rest of the flight, the rocket was not stabilized along any of its axes.

At 47.8 seconds, the aerospace complex began to break up in the vicinity of the connection between the third stage and the nose section.

At 50.1 seconds, after the blocking was removed, the engines were switched off by an emergency command from the limit switches of the gyro instruments.

The most probable cause of the failure was a combination of disturbing moments that had not been identified or considered earlier, when the net controlling moments for roll were selected.

Rocket No 7. The flight went normally for 106.93 seconds. The main parameters for the structure, propulsion systems, control system, and onboard power supply were within prescribed limits.

Analysis of the possible causes of the failure of the article indicated the following:

- the failure of rocket No 7 occurred as a result of damage to the aft compartment of section A that was due to the failure of engine No 4;
- the hypothesis of the failure of the engine as a result of internal causes does not contradict the telemetry data for engine No 4 and for the stand tests, the findings of an examination of the physical materials, or the physical pattern of the development of the failure of the article;
- the hypothesis of the depressurization of the main lines feeding fuel to the main engines and the vernier engines before the beginning of the failure is not confirmed by the telemetry data.

The cause of the failure of the engine was the burnout of the oxidizer pump.

The next launch was slated for the fourth quarter of 1974. By May, all the design and structural measures based on the findings of the analysis of the failed launches had been implemented on rocket No 8 to ensure the viability of the rocket.

The assembly of new engines with a multiple-launch history got under way. The people from the plants, design bureaus, and enterprises that had taken part in the development were preparing the rocket for flight with their former enthusiasm, because they had reason to believe that the launch would produce a positive result. But Academician V. Glushko, appointed in May 1974 as the new director of TsKBEM, which had become NPO Energiya, put a halt to the N-1 operations.

But the governmental decree closing that research area and cutting off the money didn't come until February 1976. The Americans had completed their lunar program with Apollo 17 four years earlier, after putting nearly $25 billion into it. It should be noted that, despite the grandioseness of the project, the total spending for the N1-L3 complex as of 1 January 1973 was 3.6 billion rubles [R], of which R2.4 billion went for the N-1. And the total planned cost, including that for 16 flight models (Nos 3-18), was R4.97 billion.

For purposes of comparison, it is interesting to note that roughly that much money was spent on the first stage of the rebuilding of the Gorkiy Automobile Plant in connection with the creation of a diesel truck. Here is what the newspaper TRUD wrote about that on 11 May 1991: "The building operations have already cost the country R2.5 billion. An additional billion is slated to be put in..." With that, probably even the most biased critic of "excessive" spending on the space program understands the difference between the complexities of those two projects. It must be said that Sergey Pavlovich Korolev, working under extremely tight financial and material constraints, always tried to get developers to seek out ways to get the maximum use possible of the country's scientific- technical potential and to seek out planning, design, or production techniques that were the most efficient (from the standpoint of economics) and to perfect them. That approach by the Chief had no small effect on the use of the principle of design similarity of sections; choice of section configurations, engine power, fuel components; control of flight via throttling of engine

thrust; transfer of the assembly of large rocket assemblies to tech areas right at the test range; and many other components associated with the process of creation of a new system. The relative low cost of the launch vehicle can, to a large extent, be attributed to that.

Science, technology, and production in aerospace move along paths that have never been traveled before. "On the road" to a given objective, scientists and engineers create a wealth of new things that can be used to the benefit of the national economy. That, perhaps, is exactly what could account for a considerable part of the economic return from the space program, but innovations are still not used enough. Their introduction into the economic sector is being blocked primarily by departmental barriers. It has long been time to put an end to the talk of building up the space program. We must work harder to see that its achievements are used.

Features of Method for Spectrophotometric Measurements of Natural Features

937Q0110A Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 93 (manuscript received 2 Jul 92) pp 15-24

[Article by K. Ya. Kondratyev and P. P. Fedchenko, Ecological Safety Center, Russian Academy of Sciences, St. Petersburg; Agricultural Meteorology Scientific Research Institute, Obninsk; UDC 535.33]

[Abstract] Methods for surface measurements of the spectral brightness coefficients (SBC) of natural features are reviewed and their applicability in calibrating aerospace remote sensing data is evaluated. Among the subjects discussed are: choice of a standard, solar sighting angles and altitude, extent of test sector, combinations of wavelengths and spectral resolution. The following are among the significant generalizations. The SBC measured by different measurements do not always coincide in magnitude. This is dependent on both the technical specifications of the instrument and on the optical characteristics of the investigated feature. The comparability of the SBC of natural features is not determined by individual SBC values, but by the shape of the entire spectral reflection curve. In order to measure the spectral reflectances of natural features it is necessary to use a standard whose SBC are close to the SBC of the investigated feature. The SBC of natural features are dependent on the instrument angle of view. This dependence is the greater the more the reflection phase function differs from spherical. When measuring the SBC under in situ conditions the extent of the area subjected to photometric measurements is of great importance; this extent is determined by the spectrometer field of view angle and the distance to the feature. The choice of the most informative wavelengths at which SBC measurements are made is specific and is dependent on the nature of the problem to be solved. The choice of the spectral resolution of the spectrometer is determined by the selectivity of the spectral curve for the investigated feature. The spectral range 400-1000 nm is optimal for solving many practical problems related to study of vegetation and soils. An increase in the on-line character of the data obtained by remote methods requires development of instrumentation with registry on a magnetic medium for subsequent computer input. SBC measurements of natural features at an appropriately selected angle will substantially increase the information yield of such observations. Figures 2; references 21: 20 Russian, 1 Western.

Evaluation of Influence of Incoherent Accumulation in Processing of Data From 'Almaz-1' Spacecraft

937Q0110B Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 93 (manuscript received 27 Aug 92) pp 32-35

[Article by I. V. Yelizavetin, Central Scientific Production Machine Building Association, Reutov; UDC 528.856.044.1]

[Abstract] A radiohologram obtained from the "Almaz-1" spacecraft synthetic aperture radar (SAR) was processed in an incoherent accumulation mode for a different number of subapertures. Each subaperture was synthesized by the direct convolution method with writing of an algorithm for retrieval of the quadratures. The dependence of the characteristics of the speckle noise level (taking its mean and dispersion into account) on the accumulation factor was determined. This made possible a comparative analysis of the influence of incoherent accumulation on the speckle noise level for the "Almaz-1," the Seasat, SIR-A and SIR-B. The following conclusions are drawn concerning the comparative influence of incoherent accumulation on the speckle noise level. On a radar image in the 9-cm range obtained using the "Almaz-1" spacecraft SAR speckle noise is manifested to a greater degree than on radar images obtained in the 23-cm range from the American SAR. One of the reasons for this may be the lesser wavelength of the "Almaz-1" radar. An increase in the incoherent accumulation factor exerts an equal influence on the decrease in speckle noise in the two mentioned ranges. The dependence of the speckle noise characteristics on the number of subapertures has a quadratic character in both ranges. Figure 1; references: 2 Russian.

Optimizing Design-Ballistic Parameters of Satellite Systems for Periodic Scanning of Earth

937Q0110C Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 93 (manuscript received 18 May 92) pp 48-58

[Article by Yu. N. Razumnyy; UDC 629.78.3]

[Abstract] This article is essentially a further development of an earlier study by the author entitled "Method for Optimizing Parameters of Single-Path Artificial Earth Satellite Systems for Periodic Scanning of Earth" (ISSLED. ZEMLI IZ KOSMOSA, No 5, pp 39-46, 1991). Methodological principles are now proposed for the synthesis of orbital construction of systems of artificial earth satellites for periodic scanning of the Earth with optimization using a stipulated criterion with fixed limitations. A series of results are given related to the choice of orbital parameters for an effective multiple coverage of the Earth by satellite scanning strips and with optimization of system structure using the criterion of a minimum of the maximum interruption in observation, not dependent on solar illumination. A fundamental expression is derived for optimizing the structure of correct multipath satellite systems. It is shown that there are multipath structures of identical numerical makeup and different structure ensuring scanning of the Earth with the very same periodicity. The regularities in change in the width of the multiple coverage strips and the ensured periodicity in scanning of the Earth as a function of satellite orbital parameters and system structure can be used in developing a system for automated planning of an orbital construction for a broad class of multipath satellite systems. Figures 6; references: 6 Russian.

Research on Refraction and Transparency of Earth's Atmosphere by Method of Photosurveying of Rising and Setting of Moon From Aboard Orbital Station

937Q0110D Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 93 (manuscript received 27 May 92) pp 67-73

[Article by V. N. Sergeyevich, I. I. Koksharov, K. Eerme and E. M. Pelt, Astrophysics and Atmospheric Physics Institute, Estonian Academy of Sciences, Tartu; UDC 551.46.08.551.510.42]

[Abstract] The results of a photographic survey of moonrise and moonset for estimating atmospheric refraction and transparency are analyzed. One such experiment was carried out from the Mir orbital station in September 1987 and involved a precise photosurvey of both moonset and moonrise. The exposure was 1/100 s with virtual exclusion of image blurring. The moonset survey was made beginning with an angular altitude 5° above the horizon and ending with total disappearance below the horizon. The moonrise was photographed from the moment of detection, also to 5° above the horizon. It was postulated that images obtained at altitudes of the line of sight to the center of the moon greater than 100 km can be used as standards in estimating atmospheric distortions. Using data on the actual position of the upper and lower limbs of the lunar disk and the linear distances on the image it was possible to determine the actual perihelion altitude of each detail, as well as extinction. Extinction during moonset in the equatorial zone was observed beginning with perihelion altitudes 50-55 km. Above 25 km the observational data were in good agreement with the computed values. Below 25 km, and especially below 20 km, the observed brightness of the lunar disk was systematically higher (transparency was better). In the moonset experiment, against a background of a smooth increase in transparency with altitude, there were anomalies from aerosol layers at the levels 14, 19, 24 and 47 km. Estimates of the aerosol scattering coefficient are given for these cases. Explicit evidence of aerosol layers was not discovered at moonrise. The extinction of the brightness of lunar disk details was caused by molecular and aerosol scattering and absorption by ozone. Figures 5; references: 9 Russian.

Features of Processing of Satellite Spectrometric Brightness Measurements Over Sea Surface

937Q0110E Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 1, Jan-Feb 93 (manuscript received 25 Jun 92) pp 80-89

[Article by V. V. Badayev and Ye. M. Kozlov, Space Research Institute, Russian Academy of Sciences, Moscow; UDC 551.46.0.629.78]

[Abstract] On the basis of data from aircraft experiments an analysis was made of the information content of spectrometric measurements of sea surface brightness and the factors governing it using fractal concepts on the nature of the studied phenomena. Measurements were made using an MKS-M airborne spectrometer measuring the brightness of reflected solar radiation in 13 spectral channels in the visible spectral range with a resolution 10 nm with an instrumental angular field of view 0.5 x 0.5°. The surveys were made from an AN-30 aircraft over the Black Sea during the "Black Sea-Intercosmos-83" experiment. Observations were made both before and after midday at different altitudes. The experiment revealed that when carrying out remote (including satellite) research the registered spatial variations of spectral brightnesses are attributable primarily to large-scale variations in the content of finely dispersed marine aerosol, to which the short-wave channels of the spectrometer are sensitive. The IR measurement channels may be sensitive to near-surface coarsely dispersed aerosol, but only in the absence of modulation of its radiation regime by above-lying large-scale aerosol formations. With screening of the spatial structure of aerosols in the near-surface atmospheric layer by these formations in the brightness values measured from a satellite in the near-IR spectral region this effect will be manifested in a smoothing of the real variations of the optical state of the atmosphere. The retrieval of atmospheric optical thickness in such a situation for the purpose of atmospheric correction of remote sensing data without retrieval methods differentiated in altitude, such as use of MKS-M measurement method in the absorption band of oxygen in the region about 760 nm, taking into account the real vertical stratification of aerosol, may result in undetectable errors in evaluations of the quantitative characteristics. Figures 4; references 15: 11 Russian, 4 Western.

Communications, TV Broadcast Satellites Planned

937Q0091A Moscow NEZAVISIMAYA GAZETA in Russian 23 Feb 93 p 6

[Article by Anatoliy Zak; "Reliable Voice of Russian Communication Satellites. The State is Concerned About the Development of This Space Industry Sector"]

[Text] This year government appropriations for the development of space communications in Russia are 17 billion rubles, whereas the entire civilian space budget is estimated at 54 billion.

The basis for any activity of private and governmental organizations in the space communication field should be two laws which are now being examined by the Commission of the Supreme Soviet Republic Council on Transportation, Communication, Information Facilities and Space. According to Aleksey Adrov, the chairman of this commission, the laws on communication and space activity should be presented to the Supreme Soviet in a first reading at the end of this month. It is assumed that these documents will separate the functions of governmental control and economic activity in these fields.

The Russian grouping of civilian communication satellites now consists of 10 satellites of the Gorizont type

and two of the Ekran type. They are all put into space by Proton boosters and by the "DM" interorbital module are positioned in a stationary orbit enabling them to "hover" over one point on the Earth's surface. Despite the financial problems of recent years, in order to renovate the existing grouping three satellites were launched in 1991 and five in 1992.

However, according to Mikhail Reshetnev, general director of the Applied Mechanics NPO, the low carrying capacity of the communication channels, the impossibility of correcting orbital inclination, but most importantly, the short lifetime of a satellite, which is approximately three years, are very serious shortcomings of present-day vehicles. The NPO headed by Mr. Reshetnev, located in the Krasnoyarsk region, since 1959 has developed virtually all types of Soviet communication satellites, as well as many types of geodetic navigational space vehicles. However, in the mid-1980's there was a reduction in appropriations for these programs in favor of the Buran project, which resulted in the present-day lag.

Now the "Sovkonstar" project has become the principal hope of the Applied Mechanics NPO. This satellite communication system, developed jointly with Canada, initially consisting of two space vehicles, has today expanded to five satellites. The Russian side is developing a standardized space platform, whereas the Canadian SPAR Aerospace Company is installing a highly improved communication relay system for it. The guaranteed useful life of such a vehicle is being increased to 10 years. The satellites will afford new communication capabilities for both Russian and Canadian commercial clients.

The first of 10 satellites of the Ekspress type, which in 1995-1996 should support four modernized "Ekspress M" vehicles, are almost ready for launching in late 1993-early 1994 for replacing the existing Gorizont communication system. It is proposed that the active lifetime of each satellite be increased to five, and possibly seven years, with a possibility for orbital correction.

Even now electrical tests are underway on five satellites of the Gals type with the intention that the first launching take place in the middle of this year. These geostationary satellites, for the first time in the Russian satellite program, will provide direct television to small individual-use receivers. In addition to a number of remote regions in Russia, Kazakhstan, Uzbekistan and Bashkortostan are interested in this project. The Russian Marafon satellite system should become an analogue of the West European INMARSAT system, providing communication among ships, aircraft and other moving objects. The Marafon system will consist of five stationary Arkos satellites and four Mayak vehicles, to be launched in 1991-1996 into highly elliptical orbits. In the event that financial problems are solved, by the year 2000 the total potential of the system will be 1800-2000 telephonic communication channels.

Russia also has not been bypassed by a completely new trend in the satellite communication field, now experiencing a real boom in the West. Reference is to the creation of very small and inexpensive satellites launched in "clusters" into low circular orbits at an altitude of about 1000 km. By means of these small satellites a ground user, having a miniaturized receiver-transmitter similar to a radio telephone, will be able to establish communication in the decimeter wavelength range with any point on our planet. In addition to ordinary communication, this will afford enormous possibilities for so-called "electronic mail," that is, digital communication between computer networks throughout the world.

Now in Russia, on a competitive basis and at a furious tempo, development work is proceeding on a minimum of six projects for low-orbit communication systems and only time will tell which of them will actually be realized. In addition to all else, the deployment of small satellites may provide work for our numerous intercontinental ballistic missiles which have been removed from the arsenal of our strategic forces.

However, it is likely that the towel will be thrown in for one of the promising directions in space communication. In its time the Energiya NPO proposed an effective project for launching into a stationary orbit multipurpose communication platforms weighing up to 18 tons, including 8-9 tons of purposeful communication equipment. The launching of these giants was to be accomplished using a modification of the Energiya booster supplemented by a special propulsion unit. Mikhail Reshetnev expressed extreme skepticism relative to this idea because the problem of electromagnetic incompatibility of receivers and transmitters operating in different ranges but carried aboard the same vehicle makes this project difficult to implement. According to Mr. Reshetnev, the very development of this idea went topsy-turvy because the Energiya NPO first and foremost sought work for its powerful booster instead of first formulating a group of problems and then finding the best methods for their solution.

Ekspress, Gonets, Signal, Zerkalo, Marafon, Satellite Systems Under Development

937Q0090A Moscow KOMMERSANT DAILY in Russian 17 Feb 93 p 2

[Article by Igor Rudoy: "Russian Businessmen Will Have a Choice"; first two paragraphs are source introduction]

[Text] An American banker can instantaneously call his German partner from his automobile. Between his second and third after-dinner cigars, a British stockbroker is used to pulling up his computer screen and looking over the results of trades made by his transoceanic affiliate an hour before. It's only for Russian businessmen that communications, as before, remains a major, unsolved problem. Western business circles feel

that modern telecommunications are needed no less than economic reforms if Russia is to be integrated into the world market. No appreciable improvement in the situation in that realm can be expected before 1994—when a number of commercial projects involving satellite communications for Russia will get under way (see p 1 [of this newspaper] for news about the program Rossiya, which combines several of those projects, and for news about yesterday's press conference on the program).

Below are described commercial satellite-communications projects that can be taken advantage of in the next two or three years. At the moment, they are all open to new participants and investors.

Ekspress System for Satellite-Based Telephone Communications

This system is being created by the joint-stock company Informkosmos [Moscow telephone number: (095) 267-80-21]. The founders of the company are the NPO of Applied Mechanics (Krasnoyarsk-26), the Russian Scientific Research Institute of Space Instrument-Making, the Scientific Research Institute of Radio Communications, the state enterprise Kosmicheskaya Svyaz, and the Vostok Bank. The Ekspress system is designed to transmit telephone, telegraph, and facsimile signals. It will operate by means of 16 Ekspress satellites (10 of which will be launched in the Rossiya program). Each Ekspress satellite supports the operation of approximately 4,000 telephone channels in the international Intelsat standard. The first such satellite will be placed into orbit at the end of 1993. The launches of the rest of the satellites are slated to take place at regular intervals over the course of the following three years. In the words of the director of Informkosmos, Igor Tsirlin, the cost of the project is estimated at several billion rubles.

Gonets System for Space-Based Electronic Mail

The Gonets system, about which KOMMERSANT DAILY wrote on 10 February, is to provide communications in the form of electronic mail (it is the most inexpensive type of space-based communications). It is designed for a broad circle of users: banks, stock markets, mass media, and industrial enterprises. The system is based on 36 small, low-orbit satellites. Telex or fax information is transmitted by a ground terminal to the nearest satellite in radio visibility. The satellite receives the message and stores it until the message's addressee is in radio visibility. System users—senders and receivers of information—can be anywhere in the world. Wait time for a communications session is no more than 20 minutes, and the information delivery time is under six hours. The traffic capacity of the Gonets system is 25,000 Mbit over a 24-hour period, or 1,000,000 pages of printed A4-format text.

The commercial Gonets communications system is being developed by the interbranch economic association SmolSat [Moscow telephone number: (095) 298-31-46], which was founded by the Moscow NPO Soyuzmedinform, Moscow NPO Tochnyye Pribory, and NPO Prikladnaya Mekhanika (Krasnoyarsk-26). As reported by Aleksandr Parfenov, the executive director of the SmolSat association, the spending for the creation of the Gonets system is estimated at roughly $100-150 million. The project is being financed with money provided by the founders and with commercial loans. One of the main lenders for the Gonets project is Rosselkhozbank [Russian Agricultural Bank]. The first six satellites are to be launched in 1994 by one rocket, and the communications system will be completely on line in 1996. Today, the Gonets system, two demonstrations satellites of which are already in orbit, is the only active communications system in the world that uses low-orbit satellites.

Signal System—A Competitor to the Motorola Project

Another commercial communications system based on low-orbit satellites is being developed by the Moscow NPO Energiya [telephone number: (095) 516-47-26]. The Signal system is to provide a complete spectrum of communication services—telephone, telex, facsimile, and data transmission. The system consists of a network of communications satellites capable of receiving and relaying signals from an ordinary radio telephone. Signal system users may be government or private enterprises, transportation companies, mobile construction and assembly groups, banks, and individuals. The cost of one minute of conversation on the Signal communications system would be 5 rubles [R] at today's prices.

All the operations associated with the Signal project are being financed by the International Concern for Space Communications (KOSS). The total spending for deploying the Signal system by 1998 is estimated at R4.3 billion. Energiya plans to launch the first two satellites this year and to provide to Europe and the CIS with communication services by late 1994. By that time, there will be 48 Signal satellites in orbit. The American company Motorola is working on a similar low-orbit-satellite project that is being widely discussed around the world and is called Iridium; it is to provide the same gamut of services that Signal provides.

Zerkalo Communications System for Database Exchange

Zerkalo is a special, high-speed information-transfer system for database exchange. It will effect the exchange of information between local computer networks and large databanks in real time. the Zerkalo system is being developed by the closed joint-stock company Noos Space Technologies [telephone number: (095) 575-51-69], which is made up of the Lavochkin NPO, the NPO of Automatic Equipment and Instrument-Making, and the Moscow commercial firm Noos.

For this system, a single geostationary Zerkalo satellite (a satellite stationary in relation to the Earth's surface) will be launched in 1995; it will be able to provide communications to most of Russia and to the central Asian countries of the CIS. In the words of Nikolay Morozov, general director of Noos Space Technologies, no other specialized system for database exchange is being created

in Russia. The cost of the entire project, with ground equipment, is estimated at $90 million. Among similar foreign systems, the best known is the American system Intelsat 6, which is based on five geostationary satellites and has cost $600-800 million.

Marafon System of Mobile Satellite Communications

The Marafon satellite communications system, with mobile facilities, is designed to set up telephone and facsimile communications, data transmission, telex transmission, and electronic mail with users in motor vehicles, on ships, in aircraft, or at remote sites where there are no other means of communication. This communications system will be based on five Arkos geostationary satellites and four Mayak satellites. The Arkoses will provide communications to most of Russia, and the Mayaks, which travel highly elliptical orbits, will make it possible to cover the northern part of the country, which is inaccessible to the geostationary satellites. Moreover, they will also make possible the transfer of information between the eastern and western hemispheres. Because of the high angle of visibility from the ground of satellites with highly elliptical orbits, the use of such satellites makes it possible to provide steady communications "on the run," regardless of local relief or individual obstacles.

In the words of Yuriy Perov, the technical director of the Marafon Association, the Marafon system is the only system of satellite communications with mobile facilities under development in Russia that completely satisfies the requirements of the International Organization of Maritime Satellite Communications Inmarsat. The initial stage of the project was financed by Kredobank.

The first launch of an Arkos satellite is slated for the third quarter of 1994, and the first launch of a Mayak satellite, for the third quarter of 1995. Plans call for the entire Marafon system to be in place by late 1997. The cost of the entire project is estimated at several tens of billions of rubles. The Marafon system is being developed by the interbranch association of the same name. The Marafon Association [telephone number: (095) 926-24-89] was founded by the NPO of Applied Mechanics, the Russian Scientific Research Institute of Space Instrument-Making, the NPO Astra, and the state enterprise Morsvyazsputnik.

Correlation Between Space Experiment Models and Measurements Using Fractals

937Q0081A Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 92 (manuscript received 15 May 92) pp 16-23

[Article by V. V. Badayev; Space Research Institute, Russian Academy of Sciences, Moscow, UDC 911.2:528.77]

[Abstract] Inversion of data from remote sensing usually involves discriminating a definite structure of the sought-for solution of a Fredholm equation of the first kind on the basis of spectral and/or angular measurements of the field of radiation outgoing from the upper boundary of the atmosphere. This structure, or the regularized solution of the inverse problem, is found by superposing on it a priori restrictions on the physical properties of the sought-for object under the condition of competence of the used measurement model with a given experimental error. However, when making in situ experiments the quality of these models does not always correspond to real measurement conditions due to the approximate character of the mathematical description of the studied phenomena. All of this is clarified in two examples: determination of the vertical profile of aerosol extinction from nadir measurements of brightness in the oxygen absorption band 760 nm and determination of ocean surface temperature from angular measurements of brightness temperature. The fractal principle is applied and a pertinent algorithm is formulated. The possibilities of applying the method are demonstrated in the examples of processing spectrometric information from the Salyut 7 station obtained using MKS-M apparatus. The proposed method can be used in making a quantitative evaluation of the degree of consistency between the used experimental model and measurements in problems of remote sensing of the Earth in the optical and infrared spectral regions and in constructing a solution of the problem corresponding to the real experimental conditions and capabilities of the used apparatus. Without limiting generality of the examination this approach also is applicable in other fields related to the formulation and solution of similar inverse problems. Figures 4; references 13: 10 Russian, 3 Western.

Multifractal Character of Geophysical Fields Determined by Aerospace Methods

937Q0081B Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 92 (manuscript received 8 Jun 92) pp 44-52

[Article by L. N. Vasilyev and A. S. Tyuflin, Geography Institute, Russian Academy of Sciences, Moscow; UDC 528.81]

[Abstract] A new approach to analysis of the spatial structure of geophysical fields measured using remote sounding apparatus is discussed. It is based on the use of fractal geometry for investigating spatial random structures. It is shown that geophysical fields measured with a different spatial resolution can be interpreted as self-affine fractal sets with local and global dimensions. The fractality of fields determines their scale-invariant dependencies with the extrapolation of local measurements to a higher spatial level and makes it possible to find an adequate description for microscopic and macroscopic properties. The research is based on use of photographs from the Cosmos 1939, Almaz and Landsat-TM satellites and aircraft optical, microwave, radar and laser measurements. An analysis of different geophysical fields (spectral albedo, radiobrightness temperature, relief and backscattering of radio radiation at the

surface) indicates that they have self-affine fractal properties. Such fields are multifractal and are described by several dimensions. The remote sensing results indicated that the fields themselves as a natural phenomenon are scale-invariant within the bounds of limited expanses and are characterized by several fractal dimensions. The number of required fractal dimensions is dependent on the complexity of the structure of these fields. The fractal signatures of geophysical fields must be related to definite spatial dimensions. This means that in an irregular geosystem the extrapolation of local fractal properties characterizing the spatial structure of geophysical fields is limited. By decreasing or enlarging resolution it is possible to obtain adequate estimates for geosystems at different levels (local, regional, subcontinental) and in each case the fractal dimensions will have new values. Figures 4; references 7: 1 Russian, 6 Western.

Constructing Digital Relief Model of Earth's Surface Using Stereoradar Data From Almaz-1 Spacecraft

937Q0081C Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 92 (manuscript received 27 Aug 92) pp 53-61

[Article by I. V. Yelizavetin, Machine Building Scientific Production Association, Reutov; UDC 528.856.044.1]

[Abstract] The results of processing of stereoradar images obtained by the Almaz-1 spacecraft for the purpose of constructing a digital relief model are examined. The initial data used were overlapping photographs of a sector of mountainous terrain in the Fallon-Tonopah sector of Nevada taken on two revolutions with different sighting angles. Programs and algorithms were written for processing these data. Both orthographic and topographic images were obtained. The problems arising during the processing of the stereopairs are enumerated and analyzed. The method includes three principal stages: preliminary processing, correlation processing and computation of relative elevations. Software was developed applicable to IBM personal computers. A sector measuring 2.5 x 2.5 km on the ground was processed for practical confirmation of the possibility of constructing a digital relief model using Almaz-1 data. The constructed model fully corresponds to the relief represented on the 1:100 000 topographic map for this region. The matter of the errors and accuracy in determining relative and absolute elevations was not examined. The described method is applicable for plotting topographic maps for inaccessible regions where natural resources may be present. Space observations, which can be made regardless of weather or illumination conditions, are the only economically feasible way to achieve this goal. Figures 4; references: 10 Russian.

Scientific Program for Study of Earth's Atmosphere and Surface Under International 'Kosmometry' ('Cosmometry') Project

937Q0081D Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 6, Nov-Dec 92 (manuscript received 21 Nov 91) pp 91-97

[Article by V. V. Badayev, A. K. Gorodetskiy, G. M. Grechko, M. S. Malkevich, V. N. Sobolev, G. M. Tamkovich and G. Tsimmermann, Space Research Institute, USSR Academy of Sciences, Moscow; UDC 551.521:629.195]

[Abstract] The objectives of the international "Kosmometry" ("Cosmometry") project, which was formulated within the framework of the program of the Remote Sensing Working Group of the Intercosmos Council, USSR Academy of Sciences, are outlined. The work is directed toward solution of a wide range of problems in study of the state of the environment, natural resources and climatic change using technical apparatus and instruments operating in the visible and infrared spectral ranges. Work under the project has been carried out since 1983 on the Salyut and Mir stations and is continuing using scientific instrumentation in the "Kvant-2" module of the Mir station. The principal physical atmospheric and surface parameters whose determination is provided for by the program are enumerated. A table gives the principal technical specifications of the instrument complex used in this project. Some of the results are given. These findings can serve as a basis for developing instrumentation for monitoring ecological processes on the Earth. The data analysis is directed toward study of the quantitative relationships among the content of aerosol, ozone and other atmospheric gas impurities at local and global scales; establishing the dependence between ocean surface temperature changes and aerosol-cloud components determining short-term climatic changes and the greenhouse effect; research on the propagation of anthropogenic impurities and their influence on state of the biosphere; more precise determination of the dependence between the characteristics of the radiation ascending from the water layer and its content of impurities of bio- and terrigenous origin; interrelationship of spatial patterns of brightness coefficients, surface temperature and cloud fields. References 21: 17 Russian, 4 Western.

Privatization Arrangements for NPO Energiya, Sukhoy, Tupolev Organizations

937Q0128A Moscow KOMMERSANT in Russian No 5, 1-7 Feb 93 p 20

[Article by Natalya Kalinichenko, under the rubric "Privatization of Aerospace Firms": "Highly Secret Open Joint-Stock Companies"; first paragraph is source introduction]

[Text] The wave of incorporation has now reached state firms whose names have always been associated with the elitist leadership of the military-industrial complex. Until recently, those firms headed a list of enterprises whose privatization was prohibited. Last week, preparations got under way for a plan of privatization of a rocket-space firm of worldwide renown, NPO Energiya. The A. N. Tupolev Aviation Scientific-Technical Complex this week is tallying the results of a closed session involving application for shares by its staff members, and the Aviation Scientific-Industrial Complex OKB Sukhoy is amending the plan for privatization of its firm. KOMMERSANT experts feel that the precedent of incorporation of the three largest firms producing military hardware is prodding the process of privatization of other military and conversion enterprises, which are beginning to want to follow their example. But an extremely objectionable circumstance consists in the fact that it is virtually impossible to get information about the actual financial state of such enterprises.

A Year Has Passed

Early last year, Anatoliy Chubays, the chairman of the State Committee on Ownership, announced his intention and readiness to partially privatize defense enterprises, especially conversion enterprises. At the same time, the government was cautious in its approach to privatization of the enterprises of the military-industrial complex: essentially, it wanted to incorporate only those of the enterprises' subdivisions that produced civilian products. But last year was crowned with events that surprised many observers: permission to incorporate was gained by the three "giants" of the rocket-space sector—the Scientific Production Association [NPO] Energiya, the A. N. Tupolev Aviation Scientific-Technical Complex, and the Aviation Scientific-Industrial Complex OKB Sukhoy. All three enterprises, it is true, will, to varying degrees, continue to fill military orders for a long time. Such a radical change in the views of the government on the privatization of enterprises of the military-industrial complex probably stems from the fact that finding money in the budget for such enterprises, many of which have no military orders to fill, is becoming harder and harder. The government, for example, justifies giving Energiya permission to privatize, out of the need to "support the creation and operation of complex space facilities...in the face of the sharp reduction in state orders in terms of the overall volume of production" (Government decree No 1045).

Many observers feel that political concerns were certainly not low on the list of what played a role in making up the government's position—it wanted to turn the "defense people," who are traditionally considered opponents of economic reform, into its allies.

In mid-1992, the State Committee on Ownership, together with the industry ministry, compiled lists that separated the enterprises in terms of the level of priority attached to the decision-making process associated with their privatization, and they also determined the order attending a move from one priority level to another. Episodic privatization of small conversion enterprises that had not tied their future to military production began.

Initially, the Energiya association and the aviation complex OKB Sukhoy were in the category of enterprises whose privatization, according to the procedure in effect, could be prohibited by the government. But the workers went to the government with a request to allow incorporation. Primarily, that indicates the intention of those enterprises to get out from beneath the government's guardianship in order to gain a large measure of independence in terms of attracting investments. In the opinion of observers, OKB Sukhoy, which right now has no problems with military orders and is one of the best in the sector in terms of profitability, was nudged toward incorporation more by tense relations with the former department of the aviation industry.

Rules of the Game: Controlling Block or 'Gold Share'

Conferences of the workers of the three enterprises chose the "second alternative" of privileges, which proposes the redemption by the workers of a controlling block of shares of their enterprise. In the meantime, it seems quite logical to the experts at KOMMERSANT that the state agencies that decided to privatize strategically important facilities of the State Committee on Ownership would want to preserve their means of control for some amount of time. To do that, they're using some rather simple tools introduced by the 16 November presidential ukase No 1392: the government can keep as state (federal) property either a "gold share" or a controlling block of shares of the enterprise. Recall that a "gold share" remains state property for up to three years and gives the state the right of veto in deciding the more important issues associated with the activity of the privatized enterprise, that is, the ability to block for up to six months any decision that eliminates state agencies.

Apparently, the choice of a more or less rigid form of state regulation of privatized enterprises of the military-industrial complex is directly dependent on the ratio of military and civilian products produced by the enterprise. The higher the percentage of military products, the more rigid the enterprise can expect the control by the state to be in the future.

Observers note that the most rigid alternative of control was established at NPO Energiya and OKB Sukhoy, which are being turned into, respectively, the Russian

space holding company by the name of Academician S. P. Korolev NPO Energiya and the joint-stock company OKB Sukhoy. Controlling blocks of shares—in the first case of the mother company, and in the second case of the joint-stock company—are being assigned to federal ownership (government decree No 1045, signed by Chernomyrdin, and government regulation No 2456, signed by Anatoliy Chubays). In a less rigid form, that is, with the "gold share," the state will regulate the activity of the A. N. Tupolev aviation complex, which manufactures civilian products primarily (State Committee on Ownership regulation No 1061-r, signed by Petr Mostov).

But the third alternative can be the most flexible alternative when there is the desire for it, plus skillful application—gradual diminution of the controlling block of shares held by the state. Over the three-year period, the controlling block decreases on a sliding timetable until it reaches a fixed level of 25 percent. Thus, the state retains its veto right, as it does if it has a "gold share."

Secrecy as a Pungent Spice for Privatization

The privatization plan for the Tupolev aviation complex and the draft of the privatization plan for OKB Sukhoy provide for the appearance of their shares on the securities free market (with Tupolev, shares totalling 227.97 million rubles [R], or 49 percent of the total quantity of shares, are intended for sale). But the experts at KOMMERSANT cannot yet share the special joy of the readers, who are rubbing their hands together in anticipation of the public check sales at which the shares of Energiya, OKB Sukhoy, and the Tupolev Aviation Scientific-Technical Complex will appear: one can only guess what the investment-related attractiveness of the shares of the future private joint-stock companies will be. Intuition tells us that the shares are extremely attractive: the Western market is well aware of, and is gladly buying, attack planes and fighters that bear the well-known designation of "Su," not to mention the spacecraft and orbital stations of the Energiya firm.

But assessing the financial state of the firms is not possible: many of the financial figures needed for that remain secret, even though, according to privatization legislation, buyers have the right to see the privatization plans and the balance sheets of the enterprises whose shares they are getting ready to buy. For example, according to information gathered by KOMMERSANT, the balance sheet of OKB Sukhoy and the average number of employees at the enterprise are secret.

Is it not a consequence of those secrets that we have situations in which the charter fund of a firm with a worldwide reputation like that of OKB Sukhoy is ascertained to be only several tens of millions of rubles or, as with another, no less well-known firm, the charter fund is one-fifth the value of uninstalled equipment, and public sales are conducted on enterprise premises that are closed for visitation?

Thus, the problems that investors are running into—even in the purchase of shares of ordinary enterprises—in terms of maximum openness regarding information about the enterprises that are being privatized and in terms of the access to that information will become worse in the near future, especially in the transition to massive incorporation of conversion and defense enterprises.

Some officials at the State Committee on Ownership feel that, against the backdrop of this grandiose success—very large defense enterprises won from the military-industrial complex—it appears paradoxical that certain fairly small conversion firms from those "prohibited" lists are not in a position to break away. But in the opinion of KOMMERSANT experts, there's not so much that's paradoxical there: permission is submitted for approval in the higher echelons of authority and requires strong support and lobbying. For example, for permission to begin privatization, Energiya needed the consent of the Supreme Soviet Committee on Aspects of Economic Reform and Ownership and the Republic Council Commission on Transportation, Communications, Information Science, and Space; getting that consent and registering the decision with the government too nearly two months.

The Tupolev aviation complex includes, in addition to the head design-production association in Moscow, eight subdivisions, including design bureaus in Samara and Kazan, the Zhukovskiy flight-testing facility, and an experimental plant. The association produces the TU-134, TU-154, TU-155, TU-156, TU-204, TU-214, TU-304, TU-334, and TU-22M3 aircraft and other types of aviation equipment. The complex occupies a parcel of land covering 115,530 hectares. The joint-stock company A. N. Tupolev Aviation Scientific-Technical Complex was registered with charter capital of R465.2 million. Some 14,000 personnel have received the right to purchase a controlling block of shares in the context of the second alternative of privileges, with an elevated index of 1.7 (R1,700 per share at a par value of R1,000). According to the privatization plan, 49 percent of the shares, for a total of R227.95 million, are to be sold on the securities market. A total of 20 percent of the shares are being reserved for sale at investment tenders, and the other 29 percent will be put forward for check auction. The value of the capital assets of the association is R199,396,000, with the balance profit as of 1 July 1993 at R77,728,000.

One of the leading aviation firms of Russia, OKB Sukhoy includes a design bureau, an experimental production facility, and a final flight-testing facility. The firm, which does scientific-research work and develops documentation and designs of experimental models, is well known abroad for its Su-27 fighters, its Su-24 and Su-25 attack planes, and its Su-26 and Su-29 aerobatic planes. The balance value of the complex's capital assets as of 1 July 92 was R63.6 million.

Scientific-Production Association Energiya is the leader of Russian rocket-space machine-building, as well as of spacecraft, orbital stations, and the Energiya launch

vehicle, and is known as the producer of numerous military systems. Holdings include a head design bureau and an experimental machine-building plant (in Kaliningrad, in Moscow Oblast) and the Volga and Maritime affiliates (in Samara and Primorsk, in Leningrad Oblast). The charter capital of the future holding company will consist of, according to preliminary estimates, nearly R1 billion, and the charter fund, nearly R600 million.

RSA Director Koptev Interviewed on Prospects for Space Sector

937Q0126A Moscow ROSSIYA in Russian No 17, 21-27 Apr 93 p 11

[Interview between Andrey Vasilyev and Maksim Krans, ROSSIYA correspondents, and Yu. N. Koptev, director, Russian Space Agency: "Russian Cosmonautics: the Rumors of Its Death Are Greatly Exaggerated"; the first paragraph is an introduction]

[Text] Cosmonautics always has been entered in the official register of our achievements. And all of us, sometimes without being aware of it, have already entered into a new era, although the Soviet Union has solidly retained the status of a space power. Will Russia retain this status for itself? This matter is discussed by Yuriy Koptev, general director of the Russian Space Agency.

[Interviewer] How do you, Yuriy Nikolayevich, and your colleagues feel about the attacks which have been made and indeed, are still sometimes being made, on your branch?

[Koptev] If you are speaking of the criticism of the "launchings for show," this criticism was in large part proper. But it would be incorrect to extend this criticism to the entire enormous space program. After all, manned flights have accounted for no more than 12-15 percent of the resources expended on space. In addition to these, there also have been communication satellites, systems for remote sensing of the Earth, mapping satellites for different branches of the economy and global ecological monitoring and systems for investigating geophysical processes, making it possible to predict and warn of calamitous events. And, naturally, assurance of our safety.

[Interviewer] To what degree has the economic crisis in which Russia now finds itself exerted an influence on the space industry?

[Kopatev] When we speak of the situation in our branch it cannot be separated from the entire economic picture. It is a component dependent on the social, economic and political conditions in the country. This situation is today being influenced primarily by two factors: the end of the cold war, which resulted in a reduction in military programs, and entry into a market economy, shutting off the uncontrolled expenditure of budgeted funds.

In comparison with 1989 the financing of the space industry has been reduced by approximately 40 percent. Accordingly, the completely legitimate question arises as to whether under such conditions Russian cosmonautics can survive. It can if we carry out serious restructuring. And it is necessary to begin with regrouping. Whereas more than a million workers were employed at branch enterprises at the peak of the military face-off, now it is necessary to reduce this number to 200 000, concentrating space programs at enterprises having the greatest intellectual and technological potential.

[Interviewer] How, in your opinion, is it possible to explain the fact that four or five times more specialists are employed in our space industry than in the United States?

[Koptev] To be sure, it is our backwardness. Although the space branch also accumulates all that is best and most progressive that there is in the scientific-technical potential of the country, at the same time it also reflects its level. And despite the fact that Russian electronics by no means is at a due level and lags behind the West by an order of magnitude, we nevertheless were forced to make the electronic "filler" of rockets and space vehicles from that which we had. Because up to the present day neither a developer nor a builder has the right for "ideological" reasons to use foreign components. The sole exception is foreign equipment in interplanetary projects.

Earlier we launched up to 120 satellites per year, and on this basis we were accused of the militarization of space. But in fact our vehicles had a lifetime of 3-5 years, not 14 years, like their American and European "comrades." So that we maintained parity not on the basis of quality, but quantity, and in order to equal the same volume of work as in the United States we had to expend a great deal more effort.

However, in my opinion this does not at all mean that ours is a poor cosmonautics. It simply corresponds to the general economic level of Russia, the level of its technology and culture. The fact that with all our difficulties we can today solve such complex problems in my opinion represents an enormous achievement.

[Interviewer] Now, when there is no longer a need every year to develop and construct such a number of military missiles, many factories have found that there is a need for a radical reorientation of production. But will it not be a squandering of resources and very up-to-date scientific and technical potential if they switch over to the production of goods of mass consumption?

[Koptev] Yes, I feel that it is criminal to switch rocket construction plants to the production, for example, of frying pans, maybe even teflon frying pans. Any space system in its nature is convertible. The differences between civilian and military space systems are quite nominal. For example, only quite recently the threshold of resolution of civilian satellites was more than five meters; all smaller objects could be registered only by vehicles belonging to the military department. Now the

requirements are higher: a threshold of about two meters, and a whole series of satellites was thereby "demobilized."

In addition, at almost all our enterprises parallel production traditionally existed: at them it therefore is possible to reduce the military fraction and increase the civilian fraction. But the Russian leadership must understand that it is insufficient to utter the magic word "conversion" and things will take care of themselves. The postwar experience of the United States and other countries shows that in order for conversion to get under way it is necessary to invest considerable sums in defense plants, to protect the social needs of their workers, and only then in several years is it possible to proceed to the production of goods which are actually needed by the country. It is a matter of mass reorientation and retraining of enterprises and people. Naturally, this must be done intelligently so that first-class specialists, working at the high-technology level, are not transformed into stone age production workers.

[Interviewer] What do you think, will your branch be able to pay its own way?

[Koptev] It would be naive to hope that civilian cosmonautics will be able to be self-sustaining. To require space programs to be profitable is completely senseless. As indicated by world experience, under market conditions there is only one field which pays for itself: telecommunications. All the remaining spheres are dependent on the state. In our country as well only space communication systems cause enthusiasm in commercial circles: more than 20 private projects for such systems are now being developed in Russia.

We also are laying great hopes on commercial launchings, which can bring us the foreign exchange which we need so badly. We are in a position to carry out 4-5 such launchings annually, but under the condition of allowing foreign investments—and more. It is true that it is not so simple to break through into the world space services market because it is divided up among very large Western companies and they are not at all burning with desire to let us in.

However, it must be recognized that commercial activity will not yield a great income. Accordingly, the space branch in Russia, as in other countries, also in the future will be dependent on state subsidies. However difficult the present-day economic situation may be, I am sure that in the planning of our activity it is impossible to proceed solely on the basis of momentary advantage. Any schoolchild knows: it is sufficient to miss only a few lessons in order to fall behind for a long time, if not forever. We, however, in slowing down the growth of Soviet cosmonautics, thereby deprive ourselves of the branch moving at the forefront of scientific and technical progress. The future will severely avenge itself upon us for doing this.

For some time it seemed that we would come to precisely such a dismal end. However, today the situation in many respects has changed. Our agency, which has become the successor of the former structures, has received highly important support from the Russian leadership.

[Interviewer] You recently presented a 10-year program for the development of national cosmonautics. What are its priorities?

[Koptev] In this program the priority must be on projects which are directed to the solution of socioeconomic problems. The basis for this work is the interests of the direct users of the results of space activity: communication specialists, geologists, seamen and meteorologists, in response to whose orders one type of technology or another will be developed.

In addition, we intend to ensure the independence of the Russian space complex. Although 85 percent of our scientific-technical and productive potential was concentrated precisely in Russia, some vitally important production facilities and structures are now in neighboring countries. For example, satellites can be put into geostationary orbit only by means of the Proton and only from Baykonur. Our Plesetsk cosmodrome does not have such capabilities. However our future relations with the CIS states may go, we must be sure that we will be able to carry out the goals which we have set ourselves.

And still another important point. Today we are actually finalizing ideas and projects which were initiated many years ago when work toward the future had declined almost to zero. Accordingly, it is extremely important to find resources for fundamental research, for the finding of promising technologies. Incidentally, the program also retains such directions as investigations of circumterrestrial space, solar-terrestrial relationships and study of other planets.

Naturally, the entire program is permeated by the spirit of international cooperation. Having been for many long years "closed" and supersecret, the branch no longer can develop successfully outside the world community. But cooperation is not a goal in itself or a means for solving political problems; it is intended to give an economic advantage, to bring to the country scientific-technical, technological and intellectual enrichment.

[Interviewer] Now that your branch is in the restructuring process, is there not a danger of appearance of a rent in the space shield of Russia?

[Koptev] Quite understandably such a danger does exist. It has been caused not only by economic and technical factors, but also is a fallout from the breakup of the USSR. For example, we lost an entire year in coming to a general agreement with Kazakhstan, where, as is well known, our principal cosmodrome is located. In addition, with an increase in the rights and authority of regions a problem also has arisen with launchings: Yakutia and Novosibirsk Oblast, where impact regions are located, are opposed to tests of boosters.

For these, and yes, for other reasons, we could not implement the plan for putting military satellites into orbit. Nevertheless, the systems which solve the problems involved in making observations of the Earth and the early warning system are operating quite efficiently. Although the military people are now receiving a lesser volume of information, it cannot be said that we have stepped over the danger line in this respect.

[Interviewer] Yuriy Nikolayevich, do you feel that under present-day conditions our space industry will be able to survive and rise again?

[Koptev] Today I can speak of this with great assurance because in all authoritative structures and in public opinion the understanding is gaining strength that the need for space activity is not a luxury, not a whim, not a desire to show the world our superiority, but a necessary condition of development. In any case the rumors of the death of Russian cosmonautics is "greatly exaggerated." I wish to believe that Russia was, is and will be a space power.

Mishin Interviewed, Argues Against Manned Space Flights

937Q0118A Moscow NEZAVISIMAYA GAZETA in Russian 13 Apr 93 p 6

[Interview between Vladimir Yelisovetinskiy, NEZAVISIMAYA GAZETA correspondent, and Academician V. Mishin: "'I Contend That There Is No Cosmonaut Profession.'" Academician Vasiliy Mishin Speaks Out on Soviet Space Programs"]

[Text] Yelisovetinskiy: When Yu. A. Gagarin, the world's first cosmonaut, rose into space no one had any doubts that so it should be and so it would be forever. How did it happen that we were the first in space?

Mishin: To tell you the truth, we accidentally outpaced the Americans. Without even thinking of manned flight into space, Soviet scientists headed by S. P. Korolev developed for delivery of a hydrogen bomb an intercontinental missile of far greater power than was necessary. In the United States at that time there were no hydrogen weapons and, naturally, no corresponding boosters. Thus, against all expectations we took a considerable lead in the space race and therefore we were able to launch both the first satellite and the first man into space.

Yelisovetinskiy: In such a case why did we not fly to the moon?

Mishin: This is a special story. Bewitched by the first successes in space, we did not note that the difference in the similar launchings of our cosmonauts and American astronauts was only several months. At that time this fact alerted no one. Everyone somehow remained calm, and when they came to it was already too late: the Americans were the first to land on the moon.

Indeed, the American space program, adopted under President J. Kennedy, primarily pursued a single goal: to raise the prestige of the United States, undermined by the USSR successes in space conquest. Great sums were allocated for solving the problem of landing American astronauts on the moon: 472 dollars per each American family. During the peak period in 1966 more than 500 000 persons, employed by 20 000 companies, participated in work under this program.

From the very beginning of work under the Saturn-Apollo program the objectives were clearly formulated and organizational forms were defined making it possible to reduce the bureaucratic red tape to a minimum, which we were unable to do. The program was not secret, like in our country, and the free flow of information among those involved, as well as among higher- and lower-level organizations, made possible effective accountability and monitoring of the course of the work.

What happened in our country? The first person who began work on conquest of the moon was S. P. Korolev, who charted the real ways for cosmonauts to fly around the moon and land on its surface with return to the Earth. The Luna automatic vehicles were stages in finalizing structural elements and surface facilities of the rocket-space system for lunar research during tests of manned spaceships.

However, in 1961 the enterprise headed by V. N. Chelomey was assigned work on the rocket-space complex intended for flight around the moon on the basis of the "UR 500" booster. S. P. Korolev thereby was seemingly dismissed from the lunar program, despite the fact that his special design bureau was assigned the task of developing the "N-1" booster, putting into circumterrestrial orbit a payload of 75 tons with a launching mass of the entire complex of 2200 tons.

Without question we could have made a flight to the moon, but only after the Americans, if their experience had been used (as they did after launchings of our artificial earth satellites and the first man), but our leaders at that time listened to the opinion of specialists and scientists participating in development of the "N-1" program. Indeed, a detailed project drawn up in 1972 provided for a single ship original two-step scheme for the landing of three Soviet cosmonauts in any region of the lunar surface with a duration of their presence on the moon up to 14 days and with direct return from the lunar surface to the Earth at any moment in time. This project could be realized in 1978-1980. Unfortunately, this project was not adopted.

Yelisovetinskiy: What do you think of the project for a flight to Mars?

Mishin: Why do we need it? After all, according to the most modest calculations the estimated cost of this expedition is approximately 50 billion dollars. Convert these dollars into rubles, even according to the most favorable exchange rate, and you see how much it turns out to be for us. But in our country and in society such

conditions now prevail that an unintentional spark can lead to an explosion of popular indignation. The bare shelves of our stores, lack of confidence in the future—such are the moods prevailing in our life. Space, on which tens of billions of rubles have been spent, yields no profit. Our satellites are five times poorer than American satellites. They require far more energy and their efficiency and the information yield from them is far less.

Yelisovetinskiy: You have drawn a very gloomy picture. Is it possible that our cosmonautics never will become profitable and lucrative?

Mishin: That will only happen when we have learned to count the people's money. Now all our resources must not be directed to manned flights, but to the development of modern automatic satellites: radio, television, geodetic, mapping, because 80 percent of the problems in space can be solved without man's participation. At times his presence on board is even a hindrance. Man must be in space when he really needs to be there.

I contend that there is no cosmonaut profession because in space only 20 percent of a cosmonaut's time is spent on really productive work and most of the time is spent on preparations for takeoff and landing, physical exercise and sleep. So that at the present time manned flights are entirely unnecessary.

Journalists' First Visit to TsNIIMash Described

937Q0116A Moscow GUDOK in Russian 25 Mar 93 p 3

[Article by V. Kamyshev: "Into the Holy of Holies of Cosmonautics"; the first paragraph is an introduction]

[Text] For many long years considered secret, even supersecret, the key institute of the Russian Space Agency (including the Flight Control Center), designated by the acronym TsNIIMash [Central Machine Building Scientific Research Institute], has finally swung its doors open. We were the first journalists entering into the holy of holies of the leader of world cosmonautics. This happened on 17 March.

Since May 1946, the date when the State Union Scientific Research Institute No 88 was established as the principal base for scientific research, planning-design and experimental production work for the mastery of liquid-propelled rockets, not a single outsider has set a foot on the premises. The patriarch of cosmonautics, S. Korolev, worked here. The first controllable rocket, the R-1, with an altitude of ascent up to a hundred kilometers, the R-2 long-range ballistic missile (flight range 600 km), and then the famed multistage "No 7," emanated from here. Independent enterprises were established on the basis of NII-88 affiliates: Energiya NPO, NIIKhimMash, OKB-2 Engine Special Design Bureau, Measuring Instruments NPO, and others.

Today the TsNIIMash with its design bureau is continuing to determine the progressive development of rocket-space technology.

"Civilized life on the Earth would now be impossible without space conquest," emphasized V. Utkin, the institute director, in his concise introductory speech. "The apparatuses which we developed, many of which are the only ones of their type, are necessary for the successful flight of rockets, including our unique orbital laboratory, the Mir."

But particularly invaluable in this very old institute are the people, in the words of Vladimir Fedorovich being the national pride of Russia. Here 600 doctors and candidates of science are at work, many of whom have worked at the enterprise for 30-40 years.

In one of the sections at the institute they showed us an enormous complex of piston-driven gas-dynamical apparatuses. These are powerful gas guns. The length of one of them, the PGU-VII, is 42 meters and the diameter is 0.46 m; the weight of the "shell," the piston, is three tons. The high level of the parameters of the gas streams in these apparatuses, due to their great power, under terrestrial conditions makes it possible to simulate the trajectory conditions of flightcraft motion up to a velocity exceeding the speed of sound by a factor of 20. This type of apparatus has been used in investigating the aerodynamic and thermal characteristics of most of the hypersonic vehicles constructed in our country, including the Soyuz and Buran. But recently research was carried out on the aerodynamic qualities of models of the French Hermes. The technologies developed here are making it possible to ascertain a set of trajectory parameters and aerothermo- and gas-dynamical characteristics of a new generation of flightcraft of the Saenger type.

I admit that a cold chill involuntarily ran through our bodies when we entered some of these apparatuses. They were astonishing in their volume, power and configuration. From here the constructed vehicles are sent directly to the distant stars, in large part for the first time in the history of mankind. Here is the threshold of space, a small part of it. Here, under conditions approximating those in space, an evaluation is made of the quality of rockets, which then, like people, enter into history.

We experienced similar sensations in one of the gas-dynamical pressure chambers. Its volume was a thousand cubic meters, its height was 20 m and the inside diameter was 8 m. In such pressure chambers tests are made of the influence of many factors, including rarefaction, pressure, thermal flows, forces, gases, etc., on the investigated objects. An entire complex of apparatuses with a stream velocity up to 10 times the speed of sound has been developed at the Aero-Gas-Dynamical Center. Here all of our country's boosters, manned, satellite and automatic space vehicles, descent modules for the delivery of materials from an artificial earth satellite orbit, etc., have been finalized.

The words "for the first time" have been attached to many kinds of highly complex work which has been done here. This also applies to the quenchers or dampers of

the oscillations of liquid fuel in the tanks of rockets and space vehicles created in the Launching and Spaceflight Section. Physical modeling methods, making it possible to investigate all the processes arising during spaceflight, have been developed in this same section.

I ask V. Utkin, the director of the institute: "What effect is the changeover to a market economy having on your work?"

"A negative effect, more than anyone would think. Our experimental base, like the technologies which have been developed, is too specific for any rapid changeover to commercialization. And state orders have been sharply reduced. Many unique apparatuses are standing idle."

However, conversion is gradually affecting even this narrowly specific enterprise. In one of the sections we saw a rather large skillfully executed model of a Yakutian open pit where diamonds are produced. Harmful gases are accumulating in an enormous open pit 4.6 km long. Work has been at a standstill for 2-3 days. TsNIImash specialists offered their services. By means of injection of compressed air eddy movements are induced in the open pit and in a short time it is cleared of gases.

In addition, by means of our apparatus institute workers have intended to rework old automobile tires. After separation from the cord, the rubber from these tires is reprocessed and again put into production for fabricating rugs, articles useable for medical purposes, long-lived road pavements, etc.

The equipment in the section with piston-driven gas-dynamical apparatus is capable of reproducing an explosive controllable process. This makes it possible to use the apparatus in this section in such fields of the economy as petroleum production, metalworking, etc."

"We can even fabricate such space products as monocrystals in the laboratory, although for the time being this is very expensive," stated the institute director in conclusion. "The technical level of our experimental base is very high. We have created all this little by little through the decades and we are proud of what we have accomplished. These achievements are considerably raising the prestige of our country."

Flight Control Center Seeks to Market Capabilities to Foreign Clients

937Q0114A Moscow NAUKA I BIZNES in Russian No 8, 5 Mar 93 p 10

[Article by Svetlana Omelchenko, NAUKA I BIZNES reviewer: "Preparation For the 'Mars-94' Program Has Begun"]

[Text] It involves, first of all, modernization of the technical equipment in the computer complex.

Equipment produced in our country has been traditionally used for work in space. It was assumed that this would ensure us a definite nondependence on suppliers. But gradually our lag in the field of computer technology ceased to be a secret, even for ourselves. Several years ago the first computers of the leading foreign companies appeared at the Flight Control Center and are in active use. Now in matters of modernization the prevailing rule is not so much patriotic principles as needs and capabilities. The first have increased and the latter have decreased considerably due to well-known factors. However, the specialists here are not throwing up their hands; they are seeking ways to earn money.

The very thin stream of revenue received from the permanent agreement concluded with Inturist, feeding tourists to the Flight Control Center, is not capable, to be sure, of meeting all the needs of this unique enterprise and the enormous number of people working here. The principal and until recently almost the sole source of income was advertisement. The constantly increasing flow of guests from different countries, interest in everything about what people are doing in space, which in these countries, in contrast to ours, is not weakening, but instead is increasing with the flights of their own countrymen, is attracting a great many advertisers. The technical capabilities of the Flight Control Center make possible the colorful rendition of the most diversified kinds of advertisements on the screens in the main hall and the transmission of such advertisements from space to any television studios in the world.

The Flight Control Center ensures communication with the countries of America and Western Europe during the time of TV contacts.

Advertisement in space is exceedingly effective. You can confirm this yourself if you eat what is advertised. But it by no means exhausts all the possibilities of the Flight Control Center. The unique specialists have an enormous technical and scientific potential.

"We are ready under contract to work with all interested organizations on their principal theme: to undertake monitoring of any objects in space, such as communication satellites and scientific space vehicles engaged, for example, in investigation of natural resources," stated Valeriy Udaloy, first deputy chief of the Flight Control Center.

He stated that from the Flight Control Center it is now simultaneously possible to monitor seven different space programs, including manned space vehicles and interplanetary stations.

Information from aboard a space vehicle is transmitted to ground tracking stations and via surface and satellite communication channels it is sent to the Flight Control Center. Every second about 10 000 parameters are processed. No crew is able to evaluate the situation more precisely than it can be done from the ground.

Telemetric data are used in making ballistic measurements, sending radio commands to space vehicles, controlling motion of a space vehicle, such as the Mir station, and operation of on-board systems. A special

place is occupied by data on the complex of apparatus and instrumentation for supporting vital functions: gas composition of the atmosphere, total and partial pressure, temperature, humidity, etc. Automatically, by commands from the ground, it is possible to control the operation of systems and assemblies without the participation of a crew and even to maintain the necessary composition and state of the atmosphere when a station for some time has remained unoccupied.

The capabilities of relay communication satellites of the Molniya and Gorizont type are considerably expanding. From the beginning of operation of the Mir orbital complex the Altair satellite was put into a geostationary orbit in order to increase the zone of radiovisibility and the possibilities for on-line communication. Since that time during the 90 minutes of the period of station revolution around the Earth for 60 minutes it is possible to maintain direct radio communication with the cosmonauts. There is no need for this to be constant, but such a possibility exists.

The TV signal from the on-board TV camera via a relay satellite and ground measuring point is sent to the Flight Control Center. The lag is determined only by the time required for propagation of the electric signal and is not greater than 1-2 seconds. The unusually crisp and colorful picture from space makes the specialists and guests of the Flight Control Center not only passive viewers, but also participants in events transpiring hundreds of kilometers from our planet. Television equipment remained on the station after the expedition of the Japanese TBS journalist Toehiro Akiyama.

Close international cooperation also is capable of solving many global problems, saving resources necessary for the Earth. Some Western partners have expressed interest in the possibility, in collaboration with the Flight Control Center, of working on projects for modernizing, creating and improving the control systems for various space programs. A protocol on intentions was signed recently with the leading European company Matra Marconi Space, engaged in the development of programs for launchings of space vehicles, monitoring of their flights and processing of information. French specialists have been attracted by our scientific-technical potential, great experience in implementing and supporting space programs of different kinds and the capability for finalizing components of their systems in our continuously operating Mir orbital complex, something which is impossible during brief, sporadic programs.

Joint commercial and scientific-technical activity with foreign partners will make it possible with lesser expenditures of time and material resources to develop new technical apparatus and mathematical programs for their support, to improve communication systems and to construct surface stations for receiving and processing information from satellites and manned vehicles.

Costs, Benefits of Planned Mir-Shuttle Docking Questioned

937Q0109A Moscow LITERATURNAYA GAZETA in Russian No 11, 17 Mar 93 p 13

[Article by Oleg Moroz: "As Before...Millions Fly Into Space"]

[Text] Who Needs the Mir-Shuttle Program and Why?

A press conference was in progress at the Russian Space Agency. I ripped a sheet from my notebook and wrote two questions on it:

"1. What are the principal results which you anticipate from the Mir-Shuttle program? In actuality, is it necessary or is it some space show similar to the Soyuz-Apollo program?

2. What will our expenditures on this program be—in rubles and dollars? Will they all be justified?"

I sent the note to A. Medvedchikov, deputy general director of the RSA, who conducted the press conference. The latter read it and passed it to another deputy, B. Ostroumov, who is in charge of manned flight programs. Ostroumov also read the questions, folded up the paper and put it in his pocket. The press conference continued, but I heard nothing in the way of enlightenment on the subject in which I was interested.

The next day I phoned Ostroumov. He apologized: he said there wasn't enough time. We agreed to meet. With respect to the expenditures on the Mir-Shuttle program, the following conversation took place between us:

I: So, what is the total sum which you intend to allocate to this program?

Ostroumov: There will be no special expenditures on this program. The Mir is continuing its flight. During 1993 we for the time being are planning to spend a total of about five billion on the manned flight program. In the prices of the end of last year.

I: No, I am interested in how much we intend to spend specifically on the Mir-Shuttle program?

Ostroumov: I say once again: we do not have any budget allocation specifically for that. I can show how we put it down... If, let's assume, reference is to the flight of some foreigners in the Mir, this means that they will pay. And if, as in this case, we dock with the Shuttle, this does not require special expenditures. Moreover, for this flight we will do nothing to the Mir station. We will not add on to it, we will not restructure it...

Twice more I rather bluntly asked Ostroumov the very same question: how much money—in rubles and dollars—does Russia intend to spend on the Mir-Shuttle program? And twice, each time with the preface "I say once again," Ostroumov responded that there are no plans for special expenditures on this program.

Meanwhile, in my briefcase there was a rather detailed reckoning of such expenditures prepared at the Energiya NPO about which Ostroumov, it goes without saying, could know nothing: he was settled in at the RSA. According to these calculations Russian expenditures on implementation of the Mir-Shuttle program will amount to 2 billion 75 million rubles and 1 million 15 thousand dollars.

Now with respect the assertion that the "Mir is continuing its flight." In the comments to this estimate it states: in order to maintain performance and to ensure functioning of the Mir station during 1993- 1995 it is necessary to have guaranteed financing in the amount of 6.3 billion rubles. Therefore if it were for the Mir-Shuttle program this money would simply not be allocated, but this program need not be given over six billion even though it was adopted, so it all comes out the same in the end.

And there's more. In order to work out any bugs in the docking techniques and joint Shuttle-Mir flight provision is being made for a preliminary Buran launching. So that another 3.62 billion rubles must be allocated for the completely withered Energiya-Buran program.

Finally, in the event that the Shuttle launching for some reason or another is postponed or its docking with the Mir does not take place, provision is being made for launching of the Soyuz-TM ship. The preparations for such a launching and its implementation would be another 480 million rubles.

So how much does all that add up to? 12 billion 475 million rubles, not counting a million dollars and then some. All in the prices of the fourth quarter of last year. And after all this it is said: "We will have no special expenditures under this program."

These calculations were made in November 1992. But in mid-January still another paper appeared (I also have it in my briefcase): "Measures for Implementing the Joint Russian-American Mir-Shuttle Manned Space Program" (proposals of the RSA for preparation of a decree by the government of the Russian Federation). Here the amount of ruble expenditures on the Mir-Shuttle program remains unchanged, but in place of the 1 million 15 thousand dollars it is necessary to allocate 2 million dollars in 1993 and another 2 million in 1994. But not just to anyone, but specifically to the Russian Space Agency. "The specific purpose being for supporting work under the Mir-Shuttle program."

But is it possible that Boris Dmitriyevich also knows nothing about these proposals? Not really; it was precisely he who on 18 January directed these proposals for collation to Yu. Semenov, director of the Energiya NPO (once again, a copy of the cover letter signed by B. Ostroumov is inside my briefcase).

Incidentally, the answer of Yu. Semenov also is my briefcase. He feels that in addition to the mentioned four million dollars it is necessary to allocate another million to the Mir-Shuttle program in 1995.

One has to ask why a highly placed space official had to put on pretenses and in such an obvious manner, or to express it somewhat more kindly, represent reality in a false light? I suspect that the answer is related to the first question which I asked at the press conference and to which no answer was given. Boris Dmitriyevich simply was unable to explain what specific results in science, technology and the economy might accrue to us as a result of this program. And finally he said in an apologetic tone: "You could ask what valuable results came from the Soyuz-Apollo docking? But after all we cannot say from the technological point of view that it yielded nothing..." Well yes, to be sure, after any space experiment at least something useful remains. The only question is whether this "something" will cost many billions, and this considering the very severe economic situation in the country.

Whereas no special advantages to science and the economy in general can be seen from this "something," the specific benefit to individual firms and departments can be seen quite clearly. Some commercial prospects are opening up, for example, for the Energiya NPO. In particular, the Americans are extremely interested in the docking assembly developed at this NPO and, it seems, are ready to purchase several copies of this assembly (and possibly have already made this purchase). There are some other commercial plans... As already stated, plans call for reanimating the Energiya-Buran program. Since its financing was cut off some time ago, it must be assumed that it is not considered so necessary. But now they're talking about bringing it back to life again... Possibly our scientific institutes will be able to obtain some money from foreign partners by sending data on the effect exerted on the body by prolonged space flights (as is well known, we were ahead in this field)...

The RSA itself is clearly interested in the Mir-Shuttle program. Under this program it will obtain additional financing (including in foreign exchange); there will be business trips abroad; the matter of opening its own mission in Washington is being raised; there are demands that it will have the right to conclude commercial contracts related to the Mir-Shuttle program and be free of the obligatory sale of foreign exchange; it wishes to acquire exclusive rights for the dissemination of publicity and organization of a tourist campaign, as well as rights to intellectual property associated with the image of the cosmonauts, printed publications, etc., etc.

With respect to the commercial plans of individual companies and scientific institutes, very good, let them implement their plans. But why should this be done at the expense of the taxpayer? Why must he shoulder the burden? As is well known, commercial activity takes place under a completely different set of rules: if you want to acquire money for some project you take out a bank loan, disseminate your advertisements and seek partners...

However, if you are speaking of such government departments as the RSA, it is clear that they should receive the taxpayer's money only in a case when it is possible to see some benefit to the taxpayer himself—in the narrow or broad sense of the word (let's assume that some scientific attainments are expected), but in no way simply in order to ensure a comfortable life for the officials of these departments.

Meanwhile, Yu. Koptev, general director of the Russian Space Agency, does not tire in repeating on every convenient occasion that the Russian Space Agency, as a government department, does not have the right to concern itself and does not concern itself with commercial activity. How then to explain the commercial appetites of the agency, so clearly manifested in the governmental proposals cited above?

It is amusing that in the estimate of expenditures for the Mir-Shuttle program there also is this item: "Business trips of representatives of the Russian Federation (36 million rubles, 66.5 thousand dollars). What is this for? For government officials who will approve the estimate? For members of the committees and commissions of the parliament, in order that they will be more generous, not being frugal with the people's money?

In conclusion I want to emphasize that all this does not just apply to the Mir-Shuttle program. In the last analysis, we're talking about tens of billions or more, when in the estimates of state expenditures we are already talking in the trillions! It is something else. In the expenditures on space we have in no way departed from our old careless ways. We have still not learned to count the money which is being dumped into a bottomless pit.

Uncertain Future of Space Launch Sites

937Q0106A Moscow SEGODNYA in Russian
No 5, 23 Mar 93 p 6

[Article by Mikhail Chernyshev: "Russia Risks Remaining Without Cosmodromes"]

[Text] Kapustin Yar, Baykonur and Plesetsk until recent years were used in our space activity. But now everything has turned topsy-turvy. Kapustin Yar, strictly speaking, was not conceived as a cosmodrome. This was a site for the testing of ballistic missiles transported from Germany. Until recently only small rockets of the Intercosmos type were launched from Kapustin Yar. With the decline of the Intercosmos program the test site in actuality was left without a space workload. Several ideas have been advanced for reorienting Kapustin Yar to other purposes, which have even included the celebrated idea of formation of a German Volga Republic there. When with an increase in the power of boosters it became clear that the steppe along the Volga was not the best place for ballistic tests the rocket specialists began to seek another place, now taking future space ventures into account. The choice made was the semidesert area near the Aral Sea. The gigantic Baykonur-Leninsk (also called Tyuratam) complex was developed over time precisely there, in Kzyl-Orda Oblast.

The fate of Baykonur—if the collapse continues, and it is continuing, is predetermined. The cosmoport, as fate has willed now lying in a nearby foreign country, now seemingly has two owners (Kazakhstan and Russia), but in actuality it is needed by no one. A group of deputies of the Russian Federation Supreme Soviet which recently visited the cosmodrome stated that the intergovernmental agreement on Baykonur is not working out. Kazakhstan is allocating sums for maintaining the cosmodrome which are inadequate—only 6 percent of the sum allocated by Russia—28 billion rubles. Kazakhstan has its claims on Russia.

But life at Baykonur still has a glimmer to it. During the past year it was the site of launching of almost half the Russian satellites. Launchings of manned ships to the Mir station, including with international crews, are being carried out. There are plans for the testing of the latest rockets of the Zenit type and the modified SS-25 military missile. Specialists want to use the latter for putting small commercial satellites into orbit.

Meanwhile the mass exodus of young officers and their families from Leninsk is continuing. It can be seen at first glance how catastrophically the situation in the city has deteriorated. Whereas during recent years there has been almost no food, now there also are no quarters. The hotels constructed for engineers and scientists are occupied by who knows who and remarkable purchasing organizations. Equipment and materials are being plundered. Mothballed launching complexes are deteriorating. There is no shortage of commissions. But the result of the inspections by these people is a big zero.

Plesetsk is the youngest of the Russian cosmodromes. It was constructed initially in order to keep an aim on the territory of the United States, that is, for the launching of only military missiles. But with the development of cosmonautics it became clear that Plesetsk was more convenient than Baykonur for the launching of many satellites into orbit. Although from the point of view of energy requirements launchings in a latitudinal direction have advantages (a rocket seemingly acquires additional power due to the Earth's rotation), in such cases the space vehicle cannot scan the Earth's entire surface. The polar regions cannot be seen. For this reason the territory of Russia can be seen from the Mir station only to 52°N. Satellites launched from Plesetsk in a meridional direction see the surface of the entire planet.

With allowance for these and some other factors a division of labor was established between Baykonur-Leninsk and Plesetsk-Mirnyy. And with respect to the number of launchings Plesetsk was always ahead of its more eminent "brother." Moreover, there were times when more vehicles were launched through our northern gates than from all the other cosmodromes in the world combined.

More than the others Plesetsk has worked and is working for specific economic needs: communication, meteorological, environmental and navigational satellites are all put into orbits predominantly from launch sites lost in the forests of the Arkhangelsk region. And even during the past year, with a sharp decline in our space activity, more than 20 satellites were launched from there.

Plesetsk is better known abroad than in our own country. Launchings under international programs are being actively carried out from this cosmodrome. But only relatively recently did Mirnyy became an open city in the sense that not only specialists with "access," but also other members of the public, including foreign journalists, have begun to visit there.

Leninsk, Znamensk and Mirnyy always yielded some revenue. But those who worked there received little. Nor do they now. Whereas in the 1960's these city-test sites (or vice versa) stood out conspicuously in comparison with their open neighbors with respect to the level of wages, supplies and other "sociocultural" benefits, now they are all being very rapidly reduced to the level of a Middle Russian provincial vegetative state. And this despite the fact that the people living there permanently or on assignment from large industrial centers must in no way work below the level of world standards.

It is sometimes said that Plesetsk, in case of necessity, can be adapted for manned launchings. The launch site has remained (a copy of the "Gagarin" launch site at Baykonur), although it is true that it requires repair. It can probably be repaired, but is that necessary? This, however, would be the cosmonautics of the 1960's. But for work at the level of the 21st century it would be necessary to tear the Buran launching sites out by the roots, remove the famous landing strip at Baykonur and transport all this to the forests of the Arkhangelsk region. But there is no need for haste with this "idea."

The authorities in Arkhangelsk Oblast are beginning an active struggle for establishing a Pomorye Republic. They say that they will not be an oblast, but an independent republic; then the forests, oil, gas, diamonds, and it goes without saying, the launching complexes, will be theirs.

Historians know that the very first rocket launching site was constructed even before the war near the village of Nakhabino, in the neighborhood of Moscow. Is it possible, in order to avoid further fretting, that a window to space could be constructed there?

Entrepreneurial Group Organizing Conferences to Attract Capital to Space Sector

937Q0105A Moscow IZVESTIYA in Russian 24 Mar 93 First Edition p 6

[Article by Viktor Belikov: "The Space Program Is Becoming An Entrepreneurial Business"; first paragraph is source introduction]

[Text] Our space program may get powerful sponsors in the person of Russian entrepreneurs who have founded the Zemlyane [Earthlings] Association of Business Cooperation.

The exploration of space is a prestigious business, but a very expensive one, and today, without the help of commercial structures, it is doomed to a vegetative state. Realizing that, the president of the Russian Union of Private Property Owners, V. Shchekochikhin, has come forward with an initiative to hold regular international applied-science conferences called "Business People and the Economical Exploration of Space," the next such conference scheduled for 11-13 April, in Moscow.

Domestic entrepreneurs, the president of the union feels, have all the capabilities to continue the tradition of the Russian merchants of the last century, who, with their capital, supported the construction of a network of railroads in Russia. The international conferences being organized by the Zemlyane are, essentially, meetings between, on the one hand, key specialists and leaders of the scientific-production enterprises of the powerful aerospace complex and, on the other, those in our country and abroad who will be able to invest fairly large amounts of money in future projects and who will be able to make intelligent and sensible use of the already existing high-level technologies and applied products.

That pertains to, for example, the fundamentally new open-space electric rocket motor with a nuclear power plant; the use of the instruments and equipment of orbital satellites and automobile construction; the prediction of large gas-and-oil deposits from space photos; and the mastering of the production of small electrochemical units for producing drugs and disinfectants.

Especially attractive to business are various communications systems that, with so-called low-flying satellites, make it possible to establish contact virtually instantaneously between any two points on the globe. One such system—the domestic system Gonets, initially designed for communications between small army subunits—has been refined so much that today it could possibly be employed for civilian use. Its developers have received from a large Western company—the owner of a network of a thousand stores across the whole of Europe—a proposal to organize via satellite the daily collection of accounting reports at one of the firm's centers.

At the international conference, nearly 30 such reports—proposals to establish business contacts—will be read. The Moscow government, which has supported the initiative of the Zemlyane association, has made specific arrangements for all the activities on the Space Program Day—exhibits, children's holidays, concerts—and they will be financed with money from commercial structures and not out of the city's budget.

Commentary on NPO Energomash - Pratt & Whitney Marketing Deal

937Q0104A Moscow ROSSIYSKIYE VESTI in Russian 22 Feb 93 p 6

[Article by Vadim Chernobrov: "How to Sell a Rocket Motor"]

[Text] It was truly sensational news that a "joint marketing" agreement was signed in the United States between two giants of the aerospace industry—NPO Energomash and Pratt & Whitney. If, for the American audience, the report signified just another curious fact from the world of big business, for the Russian readers—especially those who are not indifferent to the fate of domestic science and technology—the report was soothing to the soul.

And it should be! While our leading space-sector associations NPO Energiya, the Lavochkin NPO, and the Moscow Khrunichev Machine Building Plant are merely conducting negotiations on the sale abroad of finished, science-intensive products (the Proton rockets and the Soyuz reentry vehicles), Energomash is one of the first to have actually entered into the much-desired world aerospace market. If that becomes a commonplace event for Russia, it will mean just one thing—instead of the "title" of inhabitants of a country that is a raw-materials appendage, we could all well receive the more pleasant name of "residents of a power that is the exporter of prestigious aerospace hardware."

Among specialists throughout the world, that fact has evoked a good many questions. It's generally known, for example, that the Americans look very jealously upon the placement of large orders of the leading science-intensive sectors. They haven't forgotten the word "patriotism," and neither the arguments of the military (if the political situation changes in the countries from which component parts are imported, it could paralyze the entire U.S. economy) nor the reasoning of economists (no one wants to lose control of the space market, which brings $3-$15 in profit for every dollar invested) is taken lightly. Of course, all that has forced specialists to look even harder at the participants of this noisy deal.

NPO Energomash was created in 1929 by the founder of the domestic liquid-rocket-motor-building sector, Academician V. Glushko. Beginning in 1945, more than 50 modifications of various types of motors were assembled in his shops, which were located in the city of Khimki, in Moscow Oblast. Among those motors were the most famous of motors: the RD-107 and RD-108 for the Vostok, Voskhod, and Soyuz rockets; the RD-253 for Proton; the RD-170 for Energiya; and the RD-171 and RD-120 for the Zenit. More simply said, all domestic aerospace rockets have used motors made by Glushko's firm to put into orbit the most varied of space facilities: the first satellites, manned spacecraft, the Salyut and Mir stations, communications satellites, and probes for studying the Moon, Mars, and Venus.

The firm Pratt & Whitney, which is a subsidiary of the corporation United Technologies, Incorporated, is one of the three most powerful American Companies in aerospace engine-building. It's most famous products include the RL-10 oxygen-hydrogen liquid rocket motor and aircraft engines, including those for the Il-96I. In addition to its collaboration with the Ilyushin Design Bureau, Pratt & Whitney is already delivering to Russia ventilation equipment, air conditioners, and aircraft radar landing systems. Overall, the corporation today is stable, and certainly stable enough to not be "grasping for straws." Pratt & Whitney actually made a careful selection from among the goods offered and, it would seem, did not miscalculate.

The third, and main, "party" to this agreement is the world's most powerful four-chamber liquid rocket motor, the RD-170. There are simply no other motors in the world like it, and, in all probability, there won't be any in the next five years. Specialists are impressed, of course, by the parameters of the entire unit: a mass of up to 12 tons, a thrust of upwards of 800 tons-force, and a very broad range of thrust regulation of from 50 percent to 102 percent. The motor itself is expected to be made reusable (theoretically, up to 10 launches, although stand models have successfully held up through 16 cycles). The RD-170 has already beaten a path into space as the power plant for the first stages of the Energiya/Buran rocket and the Zenit rocket, on which is a simplified version of the motor under the name RD-171. The future holds promise of its use to create large permanently active complexes in near-Earth orbit and to actually perform manned missions to Mars.

Of course, the design of such a hardware miracle was bound to encounter a number of technical problems. But the experience garnered in the process has not been for naught, and now the NPO's general director, Dr. Tech. Sci. B. I. Katorgin, is confidently declaring that his firm is in a position to develop virtually any motor with a minimum of expense and in very short periods of time. In the near future, Energomash intends to also offer on the world market its next product—the design of the world's first three-component (oxygen-hydrogen-kerosene), two-mode RD-701 motor with a thrust of 200 tons-force and a specific motor mass of 9 kg mass per 1 ton-force thrust! The use of that "dream of Glushko's people" is being proposed for a new space shuttle that takes off with a suspended tank from the shoulders of the powerful Mriya.

Orbital Solar Reflector Experiment Presents No Ecological Hazard

937Q0102A Moscow IZVESTIYA in Russian 10 Feb 93 p 6

[Article by Sergey Leskov, IZVESTIYA correspondent: "A Mirror in Space Orbit Does Not Hinder the Birds From Singing"; the first paragraph is an introduction]

[Text] On the night of 3-4 February Russian scientists carried out an experiment, unprecedented in world cosmonautics, for illuminating the Earth's surface by sunlight reflected from a gigantic mirror. Leading foreign specialists enthusiastically viewed the unique experiment. However, a prophet is not without honor except in his own country and in our country the attitude toward the work which was done was not so unequivocal.

Immediately after publication, the editorial offices were called by A. Yablokov, corresponding member, Russian Academy of Sciences, and soon a letter was received which was signed by S. Revina, director of the office of the adviser to the President of Russia on ecological problems and public health affairs.

S. Revina writes: "How will birds, fish and animals sleep when bands of gleaming deadly light pass across their nests, retreats and refuges? After all, man has always striven on moonlit nights to draw the blinds a little more tightly and doctors always advise that the moon's nighttime rays not fall on a child's crib. Such is the experience of many generations of man. And what about plants? Indeed, when the light bands race by what will happen to the nighttime breathing of our forests?"

In addition, ecologists have contended that as a result of the experiment, "which cost many millions," and which was paid for in part by oil and gas workers, caused "a price increase for both gasoline and the gas in our kitchens." The conclusion is categorical: space specialists, "in order to retain their plush space privileges," are intervening in the biosphere and are manifesting "scandalous ignorance and dilettantism."

We will leave aside the stylistics of this message. The following can be noted, in essence, with respect to these claims. According to Professor V. Syromyatnikov, less than 1 million rubles (at the present-day value of the ruble) were spent on the experiment and it is impossible to infer even a remote relationship between these expenditures and an increased price of fuels. In this stage, as was mentioned in IZVESTIYA, it was necessary first of all to check the technical specifications of the experiment. In this specific case the brightness within the light spot on the Earth's surface did not exceed 2-3 "full moons" and the solar spot with a diameter of about 4 km raced over the Earth's surface at a velocity of 8 km/s. Thus, the maximum effect which the first experiment could exert on people, animals and birds was a second of brightening an hour before sunrise. All this was easily calculated even prior to the experiment and its ecological expert evaluation would really be a departure from common sense and would be wasteful. It is not by chance that not one of the European countries over whose territory the spot raced has given any thought to protesting to Russia.

However, when organizing a global system of orbital mirrors space specialists will be keenly aware of the fact that such ecological expertise will become necessary. Such a system cannot be organized for a very long time to come. And it is intended primarily for the northern regions during the long polar night. In those places the environment, even without such a system, experiences long exposure to light during the course of the long polar day.

Russian Rocket Troops at Baykonur Attempt to Desert

937Q0102B Moscow RABOCHAYA TRIBUNA in Russian 27 Feb 93 p 3

[Unsigned ITAR-TASS report: "A Departure From 'Baykonur' Also Is Possible In a 'KamAZ' Truck; But You Don't Fly Far. You Land in the Same Place"]

[Text] A group of rocket troops of a Russian military unit stationed at the Baykonur cosmodrome has fled from the discipline of their commanders. About 20 military personnel in a "KamAZ" truck have slipped away in an unknown direction. This event was reported in the republic newspaper EKSPRESS K."

The dissatisfaction of the soldiers, as indicated by the newspaper, was due to excessive workloads. Due to the understaffing of the military subunits at the work sites intended for launching of boosters of the Proton system they had to do plenty of extra work.

This is not the first sign of troubles from Baykonur. During the past year disorder was observed among the military construction units.

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At the press center of Russian space forces the information on the AWOL status of the military unit stationed at the Baykonur cosmodrome, a group of rocket troops, was confirmed. As reported to an ATAR-TASS correspondent by Lt. Col. Sergey Gorbunov, who heads the press center, the "KamAZ" truck and all the fleeing soldiers have been detained. He did not give the reasons for the unit going AWOL, which must be looked into, but it was reported that the staffing of the personnel complement of the Russian military units at Baykonur is about 62 percent, which is obviously inadequate for a high-quality performance of service and work with technical apparatus, including launching complexes.

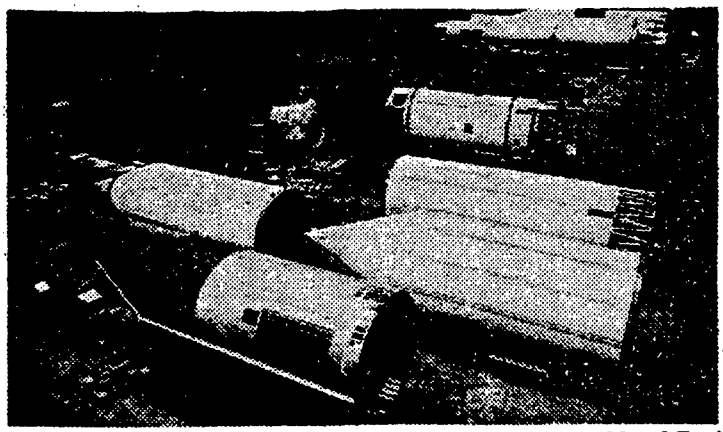
Dnepropetrovsk Rocket Producers Still Cooperating With Russia

937Q0102C Moscow RABOCHAYA TRIBUNA in Russian 27 Feb 93 p 4

[Article by Stanislav Averkov: "There Are No Customs Duties in Space"]

[Text] Five Russian space vehicles have been launched into circumterrestrial orbit by Zenit and Tsiklon boosters constructed at Dnepropetrovsk.

"We and our colleagues in the CIS not only have not gone our separate ways, we are continuing to support one another." Such was the summation of Academician S.



Yuzhnyy Machine Building Plant Production Association. Assembly of Zenit booster.

Konyukhov, the present-day general designer of the Yuzhnoye Design Bureau, in assessing the current rocket-space situation. "The Dnepropetrovsk, Moscow, St. Petersburg, Kharkov and other enterprises and organizations are doing everything so that the rockets and space vehicles created through their common work will be put to use. Only due to this the Ukraine today has some of the world's best rockets—the Zenit and Tsiklon."

"After successful completion of the Zenit flight tests unexpected accidents in the standard operation stage in 1990-1992 exerted an adverse impact on the reputation of this unique rocket-space complex," stated V. Komanov, chief designer of space complexes at the Yuzhnoye Design Bureau. "The preparations for and implementation of the last launchings drew the attention of rocket technology specialists of the commonwealth and distant foreign countries. The Yuzhnoye Design Bureau and the KMZ Production Association, in collaboration with colleagues from Russia, were able to look into the reasons for the accidents. An entire program of work on perfecting the systems was realized and the successful launchings of 17 November and 25 December 1992 were ensured. Our countries even now have decided to organize their economic and defense programs with allowance for use of the Zenit."

Goals, Options for Ukrainian Space Program Discussed

937Q0097A Kiev GOLOS UKRAINY in Russian 23 Feb 93 p 12

[Interview between Yekaterina Kindras, GOLOS UKRAINY correspondent, and Academician Yaroslav Yatskiv, director, Main Astronomical Observatory, Ukrainian Academy of Sciences: "Space Is Not a Whimsy, Space Is Our Future"; the first three paragraphs are an introduction]

[Text] Recently the first Ukrainian-Russian satellite was launched from the Baykonur cosmodrome. The Ukraine made its space debut.

Today there are more than 20 "space" powers on the Earth. We, however, have many terrestrial problems and do not suspect that we are living in a "space" country. Here and there skepticism is expressed toward such a status of our country: people say that it is all a matter of pride, nothing more. But the first interest has now been shown: in the past year the French Space Agency and the American NASA began to cooperate with their Ukrainian colleagues.

Our correspondent conducted an interview with Yaroslav Yatskiv, recipient of national and international prizes in the space research field, director of the Main Astronomical Observatory, Ukrainian Academy of Sciences, whose name has been given to the minor planet No 2728.

[Kindras] Recently the Ukraine has added still another distinction to its many others: the Ukraine is a space power. Please clarify what this means.

[Yatskiv] The Ukraine has a well-developed industrial and scientific-technical base in the space research field and qualified specialists participating in virtually all space programs of the former USSR. As a member of the United Nations our country has regularly sent to the UN reports and information on our activity in this sphere, although it was not a member of the Committee on Peaceful Use of Space. We were represented on this committee by the corresponding union member, and to be more precise—the Moscow department.

After the reunification of Germany (the GDR was a member of this committee) a vacancy appeared for which five countries applied. After prolonged debates the Ukraine was elected a member of the UN Committee on Peaceful Use of Space. Then, in addition, in 1990, Vladimir Dranovskiy, a specialist at the Yuzhnoye Special Design Bureau, took part in the work of the technical subcommission of the Committee and revealed to the entire civilized world what is today the "space Ukraine." His address became a real revelation. The world community was stunned, learning that the "space Ukraine"

was not just groundless pride, but Dnepropetrovsk, where more than 200 satellites were constructed, Yevpatoriya, where a remote space communication center is in operation...

In June of last year a delegation of the Ministry of Foreign Affairs and the Ukrainian Academy of Sciences, which I had the honor of heading, for the first time participated in a session of the UN Committee on the Peaceful Use of Space held in Austria.

[Kindras] Who now will coordinate the industrial, scientific and military aspects of the Ukrainian space program?

[Yatskiv] Three years ago at a session of the Ukrainian Academy of Sciences Presidium I raised the problem of the need for establishing such a coordinator: a National Space Agency. No one picked up on this idea, not even my colleagues. Later we returned to this matter more than once, but without results. However, the situation changed at the beginning of last year when such an agency was established in the Cabinet of Ministers. It was headed by Vladimir Gorbulin. The national agency took on itself all the organizational and coordination work in the space branch.

Today the Ukraine has three "space" centers: Kharkov (based on the Khartron Scientific Production Association, producing almost all control systems for space vehicles intended for scientific research); Dnepropetrovsk (based on the rocket construction complex of the Yuzhmash Production Association and Yuzhnoye Design Bureau); Kiev (based on the scientific institutes of the Ukrainian Academy of Sciences and the Ministry of Education, specializing in instrument making and material science). It is precisely these centers which for the most part will implement the Ukrainian space program. And there also are space capabilities in Lvov, Odessa and Uzhgorod...

[Kindras] What is this program and what are its prospects?

[Yatskiv] The national program has three principal sections: national space complexes, intergovernmental space projects, international space programs. This document outlines the scientific-space interests and prospects of the Ukraine in such spheres as space communication and information exchange, space biology and medicine, study of near and remote space, monitoring of space and development work in promising directions in advancing rocket and space technology, training of personnel, scientific information activity, etc.

Today the National Space Agency is drawing up a program, after which it will be sent on to the Supreme Soviet, because this program is national. It can be implemented no sooner than the year 2000. Accordingly, on the one hand we must knock more insistently on the European door and seek contacts with international organizations, such as the French Space Agency CNES and the American NASA. And on the other hand, cooperation with Russia must not be cut off. Because it also for the time being cannot get by without the Ukraine. Incidentally, the Academies of Sciences of the our two countries recently signed an agreement on the joint study of circumterrestrial space. Other agreements also are being prepared.

[Kindras] For many of us, people of terrestrial concerns, space is an abstract concept, not to mention scientific space. What is the makeup of the space branch of our country?

[Yatskiv] First of all, there are rocket-transport facilities and space vehicles, control systems and scientific apparatus...

The surface space infrastructure is an important component of the space branch. At Yevpatoriya we have a unique remote space communication center which earlier served all the republics of the USSR, but now the problem has arisen of how to use it. The corresponding departments in Russia insist that the Ukraine hand over the center as being their property, but our military people, to be sure, are not in agreement. We scientists, however, are inclined to feel that at Yevpatoriya it is necessary to establish an international remote space communication center. For example, French scientists now work there. In our opinion, using the Yevpatoriya center the Ukraine will be able to integrate itself in the world community on a one-to-one basis with all other countries.

[Kindras] Is the remote space communication center at Yevpatoriya a ready-made Flight Control Center (FCC)?

[Yatskiv] No, this is still not a FCC. At some point we must establish such a center.

In addition to a FCC, the Ukraine also does not have its own cosmodrome. But, indeed, there is nowhere to construct it because we do not have the enormous areas of alienated lands (space research must be ecologically safe).

Several proposals have been made on this score. One emanated from Dnepropetrovsk and envisioned the signing of an agreement with Australia on the construction of a joint cosmodrome in its territory. But for the time being nothing has come of this idea. A second variant is now being worked out. It provides for establishing a floating cosmodrome on the basis of one of the aircraft carriers of the "Varyag" class. But this project is a sort of fantastic proposal because no one in the world has any experience in constructing floating cosmodromes. Yes, and in the last analysis as of today we are not such a rich country that we can construct cosmodromes. It is necessary to make use of what is already at hand. In my opinion there are two real solutions: cooperation with Russia and Kazakhstan, using the cosmodromes at Plesetsk and at Baykonur, or, which is very difficult, but better, we must integrate ourselves in the European Space Agency.

[Kindras] Mr. Yatskiv, you propose cooperation between Ukrainian and Russian scientists in the space research field. What effect has the acquisition of the Ukraine of the status of a space power had on the scientific interrelationships between the two countries? It seems that in Russia, especially among the military people, this was not received with special enthusiasm...

[Yatskiv] To tell you the truth, for the time being we cannot get by without Russia. Now it is necessary to combine our efforts reasonably with the capabilities of countries which can do something in space research development. And Russia today is one of the strongest space powers because this branch was a very centralized sphere of activity in the former union. It was linked to the military-space complex, antimissile defense and space forces, which are still retained.

We, however, despite a very rich scientific-industrial potential, as in the theater, were always in secondary roles, and we were never invited to share in the space pie. Playing the role of a participant in the space programs, we always were only performers. We do not have organizational experience in this sphere. We have developed unique instruments, unique communication and control equipment and unique rockets, but we were never allowed to travel the path independently from an idea to its realization. Accordingly, today we must learn. For the time being we have not yet seriously developed either a coordination or juridical base. In the Ukraine there is not a single space law, whereas in the United States, for example, there are tens of such laws.

During the past year the Russian government has appropriated 6 billion rubles for its space research. How much we had is difficult to calculate. The only figure which can be mentioned is 30-35 million, received from the Committee on Problems in Science and Technology for fundamental research in this branch.

We have no right to ruin that which has been done, that which has been created over the decades. In order at least not to lose, as they say in sports, conditioning for the next year, not taking inflation into account, for the space branch we need about 15 billion karbovanets. Emphasis must be on projects of great importance for the development of the Ukraine and for its safety: space television and communication, ecological monitoring, monitoring of space and other such projects.

[Kindras] Yaroslav Stepanovich, let's descend to Earth and let's calculate: is space profitable or not?

[Yatskiv] In a pragmatic sense this subject is still unpopular. For example, the former USSR annually spent 6.9 billion rubles on space research (not taking the military branch into account). And this brought in a profit of 6 billion. At first glance it would seem to be an unprofitable sphere. But if one takes our other misfortunes into account, such that the volumes of unfinished construction amount to 180 billion, that the balances of commercial-material commodities above the norm add up to 247 billion, that unproductive expenditures are 24 billion and that grain losses are reckoned at 20 billion, a somewhat different picture takes shape.

It is very difficult to calculate the direct effect. You recall that at one time solely by means of a space radar system (incidentally, both the satellite and its radar system were constructed in the Ukraine) it was possible to free the "Somov" ship from its ice captivity. Thus, tens of lives and the ship, costing not less than a billion, were saved. Such countries as Canada, for example, have enormous profits from space research directed to the prediction of natural calamities, soil erosion, compilation of maps of mineral resources, etc. In the Ukraine there are such zones as Chernobyl, the Carpathians and Crimea which require global monitoring from space.

We must have space communication and television. Two ways are open to the Ukraine; either produce its own communication satellites or lease them, for which it would be necessary to pay an extravagant price. That is, it is necessary to be able to see an advantage. In America they call it "the side effects of space." I will not even mention that the development of space technologies results in fundamentally new technologies in general, and this means that scientific and technical progress is facilitated. Space is not a whimsy. Space is our future.

You know, in 1985 Rajiv Gandhi, during a visit to the space center in Bangalore, was asked: "how do you reconcile expensive space projects, the latest satellites and concern about some distant galaxies, with the thousands of unfortunate hungry Indian poor?" To which the prime minister calmly responded: "India must think of its future."

Space research in the Ukraine: this is the path to civilization, and this means, to our better future.

Only 25 Percent of Space Enterprises to Survive

937Q0096A Moscow DELOVOY MIR in Russian 11 Feb 93 p 2

[Article is ITAR-TASS release, under the rubric "Program": "The Space Prospects of Russia"]

[Text] Two manned missions are planned for this year: one in July in which a French cosmonaut will take part, and the other late in the year. It will be a "space marathon" lasting six months. That was reported to journalists by the director of the Russian Space Agency, Yuriy Koptev, who was outlining the space program for the period up to the year 2000.

Later, expanding on the topic of the manned space program, he said that three or four "cargo vessels" are expected to be launched this year, as well as the Spektr module, which is to become part of the long-duration orbital Mir complex. The director noted that specialists are counting on using the station until 1996. But even now, the features of its successor are being outlined. A preliminary design of the Mir-2 is on the drawing boards,

and new versions of the orbital modules, transport vessels, and cargo vessels are being developed.

But the plans stay plans if the necessary financing is not available. For that reason, serious attention was devoted to that issue at the meeting. For example, the figures of 60-80 billion were named. That is how much is expected to be released for the space program annually until the year 2000 (based on 1993 prices). Is that a lot, or a little? The specialists answer that it's "not an awful lot." It is expected to leave only 25 percent of the sector enterprises that constitute the base needed to preserve Russia's space potential, Koptev emphasized.

As for one of the important areas of activity of the sector—communications—work is under way there to create several competing systems that are of varying purposes and that use "constellations" of satellites flying in low circular orbits. They make use of "electronic mail" and are designed to provide global communications. As early as this year, 1993, plans call for the beginning of the operation of powerful, new-generation space vehicles in geostationary orbit—Gals—which are meant for relaying television programs.

The space activity of the Russian Federation is regarded as one path to broad international cooperation and safety on Earth for the good of mankind.

Administrative Problems at Leninsk, Baykonur Cosmodrome

937Q0096B Almaty KAZAKHSTANSKAYA PRAVDA in Russian 26 Dec 92 p 4

[Article by Vladimir Li, under the rubric "Problems": "Leninsk—A Closed City Open to the Winds of Change"; second half of article is collections of facts and figures pertaining to Leninsk]

[Text] The capital city of the domestic space program, Leninsk, seems to be, in fact, becoming Kazakh. There was always a dual authority here, but the real power belonged to the military. After the breakup of the Union and the declaration of the Republic of Kazakhstan as a sovereign state, Baykonur Cosmodrome and the city of Leninsk legally became Kazakh, although, until recently, all the power actually remained in the hands of the Russian military.

The head of the Leninsk Municipal Administration, Vitaliy Alekseyevich Brynkin, should get some sympathy. After receiving from the president of the Republic of Kazakhstan complete administrative authority along with his appointment, Brynkin actually found himself, in Leninsk, little more than a general without an army. There was virtually nothing to administer in the city, what with the sparsely populated administrative apparatus. There was even a case when, once, he was witness to someone robbing a cafe. He found a policeman and asked him to watch the place for an hour or so. The policeman refused, saying that it was not in his jurisdiction.

There are true paradoxes with the local police. The city police department is at the Tyura-Tam station, with a staff of 10 people. But a division of the city police department is in Leninsk, with a staff of 300. The division is under the jurisdiction of the Eighth Administration of the Ministry of Internal Affairs of the Russian Federation, and it is commanded by the head of the cosmodrome, who is under the jurisdiction of the Russian Ministry of Defense. The same kinds of paradoxes exist in the courts. There is no civil court in Leninsk, there's a military court, which is also Russian and which sits in judgement over citizens of the Republic of Kazakhstan.

Practically speaking, the head of the administration cannot influence the activity of the law-enforcement organs, which means he cannot carry out presidential ukases or governmental and Supreme Soviet decrees that involve the fight against crime. There's another issue here. Part of the function of the police is to protect state property, in this case the property of the Republic of Kazakhstan in the city of Leninsk and at the Baykonur Cosmodrome. The Leninsk police don't perform those duties in the best manner. The police department has not been an obstacle to plunderers. And a great deal has been plundered. Early this year, the Kzyl-Orda police managed to detain several columns of construction gear, equipment, and other valuable materials that were being illegally transported out of Leninsk. In my opinion, the question of whose police will be in Leninsk—Russia's or Kazakhstan's—is fundamental.

According to Brynkin, there's no talking of dual authority these days. In accordance with the policy line of the president, the process of establishing and strengthening executive authority is under way in Leninsk. In the next few months, the military are to hand over to the administration all the municipal services, the housing, all the hotels, all the social and cultural facilities, all the public utilities, and more. At work in the city is a government commission that is to estimate how many millions, or even billions, of rubles it will cost the republic to have the right to be the boss here. This year, more than 1.5 billion rubles were spend to maintain the city of Leninsk. Next year, subsidies will be considerably higher. After all, virtually everything needs to be re-created or re-organized.

If you don't count the commercial stores that specialize in selling alcohol, imported chocolate, or clothing, there is essentially no trade in the city. Earlier, the all-powerful voyentorg [commissary], which had reached the point where the per-capita commodity turnover for the population in Leninsk was almost three times higher than in the best oblasts of Kazakhstan, completely surrendered its positions, and today, even the half-empty stores of Kzyl-Orda look plentiful by comparison with those in Leninsk. So trade needs to be created anew, and that's the direction the work is taking. Generally speaking, Leninsk is unique in every regard. Here even the bread for the city is baked by soldiers.

Leninsk was built as a temporary refuge for military personnel, sort of a city-hostel. No one every thought that over a period of two decades, it would grow into a real city with a population of around 90,000 or that people would want to stay here. Which is why the city-planning policy hadn't changed until recently. They would build primarily one- and two-room apartments, which now make up 70 percent of the housing. That mistake set up a housing problem that will last 50 years. Even today, when nearly 1,700 apartments are empty, the housing problem remains. There are quite a few families here that have a lot of children and need better housing, but it's very difficult to help them. By the way, the administration does not consider empty apartments a big problem that are largely plundered after the tenants leave. After it gets the municipal services, it will have to set up all the services from scratch. For servicing the heat and electric plant alone it needs to get 700 workers. After the repair, the apartments will be given to specialists. The local populace isn't forgotten, either: recently 700 people received vouchers for housing.

To put the city services in order will take huge sums of money. Some of the money, including hard currency, could be provided by profits taken from commercial launches of satellites from Baykonur Cosmodrome. In fact, such a situation was called for in the May agreement "On How the Baykonur Cosmodrome Is to Be Used," which was signed by the presidents of the Republic of Kazakhstan and the Russian Federation. Article 7 of that agreement says that at least 15 percent of the commercial profits received are allotted to the development of the cosmodrome and the city of Leninsk. According to Vitaliy Alekseyevich Brynkin, however, not of copeck of that money has made it to the city coffers, even though there have been commercial launches.

The Russian Ministry of Communications was the client for the last satellite launch. The launch was attended by a group of German entrepreneurs who put advertisements on the spacecraft. Both the hard currency and the rubles that came out of that commercial deal went past the Leninsk treasury. If the logic of the agreement were to be adhered to, any commercial activity that made use of the Baykonur Cosmodrome would have to be coordinated with the head of the administration, who would be acting as an interested party and as a representative of the state authority in that locale. Obviously, someone representing Kazakhstan must monitor how the cosmodrome is being used, and the head of the administration is the most logical person to give that monitoring function to.

The immense intellectual wealth of the former Union resides at the Baykonur Cosmodrome. How is that wealth to be used? For now, it is not required by our scientists or agencies. But there are things to be had here, right down to the most modern technologies, for which we don't need to travel abroad and pay hard currency. Baykonur has a unique airport, the likes of which not even the United States has. Why not use it for commercial purposes, to earn hard currency? If a hotel complex were built here, we could create an international airport. I can only agree with V. Brynkin that to use the cosmodrome as a business, we need to create an intergovernmental joint-stock company, and maybe attract some foreign capital. If that were to happen, everything would fall into place, the scientific and technical potential would be used to its fullest, and the scientists, engineers, and military who live here would be assuaged, and they would have guarantees, among them the guarantee of social protection after their work or service is ended. The use of the cosmodrome needs to be placed into a higher market orbit.

The process of setting up state authority of the Republic of Kazakhstan in the once closed city is having difficulty. It's not easy because of a multitude of paradoxes that have come about in the formerly Union city located within the republic's borders. An absolutely unique phenomenon is that 80 percent of the deputies of the Leninsk city council are officers of the Russian army or members of their families. At the last session, five officers announced their candidacy for the position of chairman of the city council, despite their overwhelming majority in the council. To become chairman, one must, for a start, be a citizen of the republic. And that's not so much a questions of politics as it is ethics and respect for the sovereignty of the republic.

The head of the administration doesn't enjoy the warmest relations with the city council. Many of the deputies feel that the law about local self-rule is infringed and that too much authority is given to the head of the administration. But that law was adopted when the Union still existed. Since that time, a lot of water has gone under the bridge, and life has changed. Adjustments have to be made for the times. Brynkin himself feels that opposing the city council is often useful, the way a cold shower is sometimes useful. He gets their attention. But generally speaking, every institution of authority has its niche in societal life, as determined by the Constitution of the Republic of Kazakhstan. Every institution of authority has enough authority to do creative work to improve the life of the city. Of course, if there were some creative collaboration among the authorities, we could put our lives in order quicker.

Baykonur: Facts and Figures

The state cosmodrome testing grounds of the Ministry of Defense (Baykonur Cosmodrome) is intended for preparing and performing launches of space vehicles used for communications, navigation, and detection; ballistic rockets to orbits of 20,000-40,000 km in altitude; heavy reconnaissance vehicles; topogeodesic and meteorological space vehicles; and space vehicles with scientific and economic missions, including manned and interplanetary spacecraft and stations.

Baykonur accounts for nearly a third of the launches of space vehicles and for all the launches in the manned program. The cosmodrome is located in Kzyl-Orda

Oblast of the Republic of Kazakhstan (administrative center, Leninsk; railroad stop, Tyura-Tam).

Approximate value of the fixed capital of the cosmodrome is 10.6 billion rubles [R] (in 1990 prices).

The cosmodrome includes four centers for testing and application of space hardware and one center for testing military missile complexes.

In all, the cosmodrome has the following:

- two assembly-and-testing buildings, and in them are 354 complexes for prelaunch preparations of launch vehicles and space vehicles and four fueling-and-neutralization stations for filling launch vehicles and space vehicles with fuel
- nine launch complexes (15 pads) for sending off launch vehicles
- a tracking complex for monitoring and controlling the flight of launch vehicles
- four pads for testing intercontinental ballistic missiles
- an oxygen-nitrogen-producing plant
- a 60 MW heat and electric power plant
- a 72 MW gas-turbine power train
- 92 communications centers

The cosmodrome's transportation system includes the following:

- two first-class airports
- 470 km of railroad track
- 1,281 km of roads
- 6,610 km of power lines
- 2,784 km of communications lines

The cosmodrome's engineering system includes the following:

- 360 heat-supply pipelines
- 1,240 km of pipeline for the water supply
- 430 km of sewage collectors

The total cost of operating the cosmodrome is (at 1990 prices) R500 million a year.

The cosmodrome uses roughly 600 million kW/hours of electricity every year.

It uses 160,000 cubic meters of water per day.

The total figure for cosmodrome personnel is 31,720, which consists of 9,944 officers and warrant officers, 18,316 enlisted men and sergeants, and 3,460 employees. In addition, nearly 18,000 people who are members of the families of military personnel live in Leninsk, as do more than 95,000 civilians.

The total area covered by the main and auxiliary facilities of the cosmodrome is 6,717 sq. km.

The area of the land taken out of production for the fall of spent launcher parts is 104,305 sq. km.

Of that land, 46,010.7 sq. km are in the Republic of Kazakhstan; 44,640.0 sq. km are in the Russian Federation; 11,900.0 sq. km are in Turkmenistan; and 1,700.0 sq. km are in Uzbekistan.

[Taken from the magazine DELOVYYE LYUDI [Business People]]

Uzbek Space Agency Created

937Q0096C Moscow RABOCHAYA TRIBUNA in Russian 19 Feb 93 p 3

[Article by Rustem Tell, special correspondent for RABOCHAYA TRIBUNA, from Tashkent: "Uzbekkosmos Is Launched"]

[Text] By an ukase of the president of the republic, I. Karimov, the Uzbek State Agency for Space Research—Uzbekkosmos—has been created. Republic specialists long played a big part in the space programs of the former USSR. Of course, that was considered a big secret. Now the work in the space program will be done independently, as well as in close cooperation with specialists from other CIS states.

NIIEM Contracts for Equipment Test on Meteor-3M Satellite

937Q0093A Moscow KOMMERSANT DAILY in Russian 22 Jan 93 p 9

[Article by Yevgeniy Kamnev: " 'Meteors Fly' for Foreign Exchange"; the first two paragraphs are an introduction]

[Text] Yesterday at the Electromechanics Scientific Research Institute (NIIEM, in Istra) preparations were completed for the testing of German measuring equipment aboard the Meteor-3M satellite under a contract with the Kayser-Threde GmbH firm. The institute intends to give highest priority to the commercial use of its Meteor-3M satellite.

The Meteor-3M meteorological satellite is intended for collecting information on conditions in space, in the atmosphere and at the Earth's surface. The payload carried by the satellite is up to 500 kg. The orbital altitude is about 950 km.

It is the opinion of Rashid Salikhov, NIIEM general director, that the Meteor satellites are the ideal place for testing new space technology on a commercial basis. The cost of putting 1 kg of payload into orbit without allowance for operational costs is only 12 000-15 000

dollars. When carrying a maximum payload of 500 kg the client should pay the total cost of the satellite: not less than 50 million dollars.

The beginning of implementation of a commercial program was a contract with the Kayser-Threde GmbH firm which ordered tests of German apparatus for highly precise autonomous measurement of spacecraft orbits aboard the Meteor-3M satellite.

NIIEM specialists feel that the development and production of new microsatellites, carrying a payload of 15-20 kg, is commercially promising because the demand for satellites of such a class is steadily increasing abroad. The production independence of the NIIEM, uninvolved in broad cooperation with other enterprises in the fabrication of satellites, also should be attractive for foreign partners.

Until now the NIIEM has participated in international projects on a gratis basis. An example of this, in particular, is the Russian-French "SKARAB" scientific project providing for the installation of French equipment for radiation measurements aboard the Meteor-3M. However, this may be the last "free" launching of foreign equipment on a Russian satellite. The launching of the Meteor-3M satellite will take place this summer.

Mir-2 Space Station 'Key Project' of New Russian Space Program

937Q0092A Moscow KOMMERSANT DAILY in Russian 19 Feb 93 p 3

[Article by Mikhail Sergeyev: "A New Space Station Is Being Planned"; the first two paragraphs are an introduction]

[Text] A new-generation orbital station, the Mir-2, which will replace the existing Mir and which will become the key project in the Russian space program, is being developed in Russia. This was reported yesterday in a press release by the Energiya Scientific Production Association.

The Mir-2 project gives evidence that Russia intends to retain its leading positions in the sphere of development of orbital stations. Precisely this superiority for the time being remains the only steady source of foreign exchange receipts of Russian space companies, which may be threatened after the American Freedom orbital station, a competitor of Russian orbital stations, goes on line. For the time being there has been no decision on the extent of budgeted financing, but the experts have no doubt that the Mir-2 will be the largest item in the "space" budget of Russia.

Russia now remains the only country supporting the constant presence of its crews in an orbital station. The possibility of carrying out technological experiments under weightlessness conditions of any duration and with observation by operators guarantees Russian enterprises a unique niche in the space technologies market: flights of the Space Shuttle ship cannot last longer than two weeks and neither the Americans nor the Europeans are able to carry out long-term space research. In order to fill the gap the Americans are trying to develop the orbital station Space Station Freedom, the beginning of whose construction is planned for 1997. But for the time being the European Space Agency has allocated 150 million dollars for financing prolonged flights of European astronauts aboard the Mir station. However, in the immediate future Russia may lose its advantage because the Mir station flying today is based on the technology of the 1970's and the base unit of the station, having already been in space for seven years, requires constant replacement of equipment.

The council of chief designers of Russian rocket enterprises has advanced a design for a new-generation orbital station capable of competing with the Freedom. It is proposed that the Mir-2 be launched late in this decade. The station will be lighter than its predecessor, have a flexible structure and a high capacity of its power supply system.

The chief developer of the new station, the Energiya Scientific Production Association, intends to draw several tens of Russian enterprises into work on the project. The cost of the Mir-2 is estimated at several hundred million dollars. It is proposed that Russian and Western companies be involved in financing the project.

The basis for construction of the Mir-2 will be a framework to which autonomously controllable scientific equipment ensembles will be attached. The mass of the specialized modules has been reduced from 21 to 7.5 tons. The total mass of the Mir-2 will be about 80 tons but the size of the crew will remain in the range 2-6 persons. The orbit of the new station with be tilted 65° to the equatorial plane, which will make possible monitoring of the Earth's entire surface with the exception of the polar regions.

Conversion Programs at NPO Tekhnomash

937Q0085A Moscow DELOVOY MIR in Russian 24 Dec 92 p 5

[Article by Mikhail Rebrov, Nekos Studio, under the rubric "Science Centers of Russia": "The Voice of the Sun: Thoughts Evoked by an Introduction to the Aerospace Scientific-Production Center Tekhnomash"; first five paragraphs in bold are source introduction]

[Text]

For a Start, a Short Story

Once, the well-known physicist Gustav Kirchhoff put forth the suggestion that the so-called Fraunhofer lines of the spectrum indicate the presence of gold on the Sun.

One of the people listening, a banker by profession, remarked to the scientist, "What use is that gold if neither you nor I can get it?"

Soon after, Kirchhoff was awarded the grand Gold Medal of the British Royal Society for his development of spectral analysis. The scientist took the award to the banker and said this:

"Look, I got the gold from the Sun after all!"

That's not a parable—it really happened.

Mathematics Is the Judge

Let's admit it: the discussion of the topic "What can the aerospace sector give to our economy?" has stretched on too long. Or to be more specific, it has gotten bogged down in endless arguments in which one side says, "It's time to start finishing and closing all the space programs in the interests of what's important and needed," and the other side insists on its right to "continue." The argument of the first side is "Don't throw millions to the wind"; the reasoning of the second goes "Let's do a little counting."

Our budget statistics have reached a unique milestone: thirty-place numbers—the trillions—have appeared. Against the backdrop of such colossal sums, even the customary question of "Is it a lot or a little?" would sound absurd. And what sense would it make to compare today's trillions with last year's billions, if we're talking not about large or small amounts, but about the difference in their quality? Inflation is the magic of large numbers. It distorts all the value indicators and impairs the normal reading of them. In addition, it's not just large or small sums of money—it's also large and small investments and, consequently, large and small returns.

My reason for citing those generally banal truths was not at all to make the point that much or even very much has been invested in space programs in the past decades. The total figure—a very impressive one—can be obtained through simple addition. But to get at the profound essence of the problem, we need mathematics that are a little more complex. A plus is logic, a plus...

Then our scientific-production system will appear in all its absurdity. Or to put it in simple terms, the misfortune is inherent, unfortunately, not only in the space machine-tool industry, but also in many other sectors of the economy—we are not hurrying to introduce what is new, and we don't know how to make a profit from it. Hence the notion that space enterprises "only take," never giving anything back. In fact, everything is in order. And on the basis of some very specific examples.

Behind the Curtain of Secrecy

In this enterprise's recent past, access to it—a "closed" scientific-production center engaged in developing new technologies and special equipment for the aerospace industry—was extremely limited not only to journalists, but also even to specialists from component-making enterprises that were also "closed." Now NPO Tekhnomash has opened its doors to reveal its projects and its products, and the general director of the association—Vyacheslav Vasilyevich Bulavkin, a member of the Academy of Technological Sciences and the Engineering Academy of the Russian Federation—spoke frankly and in detail about the problems that our contradictory times have dropped on the staff. But then, to substantiate what he said, he and his deputy for science, Valentin Alekseyevich Kazakov, took me around a large exhibit that explained the possible applications in the economy of technologies, materials, and articles that were born in Tekhnomash itself or in collaboration with other firms of the same high rank. That is, at enterprises in which the latest space and rocket hardware is created.

Here was gathered the best there is in the sector. And although you wouldn't exactly call Tekhnomash a sector, I wouldn't be so quick as to "negate" the idea. In the exhibition halls, rocket-motor nozzles sit improbably, as it were, next to milking valves of unique design; a highly precise titanium-alloy casting sits next to a unique medical instrument; turbopump assemblies are next to quenching baths; units and parts from the most powerful rocket in the world, Energiya, and the reusable Buran spacecraft sit next to various-caliber welders (from large to miniature) for nuclear and space production, next to containers for the baking industry, next to many more things without which our lives would be unthinkable.

On one of the walls of an exhibit room is a beautiful photograph of the Energiya/Buran rocket-space system.

"And what if you were to put little dots on the units or parts whose development Tekhnomash took part in?" I asked Vyacheslav Vasilyevich.

"I'm afraid there would be so many dots, they'd cover the entire photograph. After all, the manufacture of that complex involved more than 20 kilometers of weld seams and 20,000 pipe joints during the assembly, and each weld and joint had to be airtight and had to be able to withstand considerable mechanical loads."

Then the general director began to enumerate the new technologies developed and introduced in the course of the creation of Energiya and Buran. There are nearly 200 examples of such know-how, and they honor the scientific-production association.

"The advantage enjoyed by the things that Tekhnomash produces," Academician Bulavkin added, "is that they are tested in extreme or, as we say, full-scale conditions. Moreover, most of our technologies can be used on domestic equipment. Tekhnomash specialists offer nearly a thousand examples of systems of machine-tool attachments. But the sphere of their application and the scales of production—those things have to be expanded and enlarged many times over!"

From Buran to Dough Mixers

In becoming acquainted with the laboratories of the Scientific Research Institute of the Technology of Machine Building and with the experimental plant and in speaking with the specialists of the association, I never

stopped being surprised at how much the aerospace sector can give to the national economy and at how little our economy is ladling out of that priceless source.

"The space program," says Deputy General Director V. Kazakov, "is usually identified with something global. That goes for the research programs, as well as the engineering objectives and the technical articles. But I'll tell you about something very prosaic. For kneading dough, the food industry uses special containers. They're called troughs. At one time, they were made of wood, but now they're made of stainless steel. But you can't stamp that kind of steel in the usual manner, because it breaks. So they try everything: some are cast, some are welded. The labor outlays are enormous, but there's no hygienic cleanliness—it's hard to get the dough and the leaven off the weld seams. We've worked out a special way to do the stamping—the rotational drawing method. It makes it possible to produce an article with a perfectly smooth surface, without any seams, lasts almost forever. The labor outlays in manufacturing are considerably smaller than with the traditional method, and you save as much as 80 percent of the stainless steel in the process."

Similar containers are used not only at bread-making plants and bakeries. They are also needed for meat processing, for making sauerkraut, for making juices, and in the pharmaceutical industry. They may be relatively small (say, 5 or 10 liters) or rather large, with a diameter of two or three meters. I asked about what the annual demand was for such an article, and the reply was 150,000-200,000 articles.

Tekhnomash has developed a method for applying ceramic coatings on articles with a plasma spray. Technologies existing abroad enable the application of ceramic coatings a half a millimeter thick only. The NPO has managed to do much better: it has developed technologies that enable the production of a layer of any thickness. I won't begin to enumerate all the production lines where the use of that technology produces a large economic impact, there are so many of them. But here's an interesting opportunity the papermakers have been given. The pulp-and-paper industry uses huge rolls that are as much as 12 meters long and that are made from solid pieces of granite.

It's complicated and expensive. But an article with the same high quality or even better quality can be made by coating a metal blank (tube) with a ceramic layer. The first such rolls were made for paper combines in Karelia. FRG and Finland are now showing interest in Tekhnomash's things.

And take a device like a filter. Filtration is needed everywhere: in the food industry, in wine making, in the production of drugs, in the petrochemical industry, etc. Making filters with fine and deep openings is extremely labor-intensive. Equipment created at the NPO simplifies the task considerably and makes the production less expensive, without a loss of quality. Abroad, filters made of perforated metal tape with holes with 50-micron diameters are considered "the cream of the crop." At Tekhnomash, the holes have been reduced to 20 microns.

Another example. Methods of high-temperature brazing were created in the past for the needs of aerospace equipment for joining paired materials like titanium and titanium, aluminum and aluminum, and metal and ceramics. Magnetic pulse welding is used to join copper pipes and aluminum pipes. A unique technique has been created for automatically bending pipes with any bend radius, without changing the attachments. Such technologies are used at the Cherkassy NPO Kompleks, where household refrigerators are made; argon welding is being introduced at the Kalinovskiy PO Pishchemash; automatic pipewelding is being introduced at the Bilibin Nuclear Power Station; and laser location and spacing of rubberized metal cord has been found to be very effective in tire production.

At the Tekhnomash exhibit, you can see all that with your own eyes: blast cleaning of large containers, soldered radiators for motor vehicles, honeycomb structures for aircraft construction, "waffle" shells of rockets, a wear-resistant cutting tool, and parts for medical prostheses. Amid all that variety, what caught my eye was a milk-line valve, which is a rather complex device and used to be manufactured with sand casting. The output of usable product was only 30 percent of the total number of initial castings, and the purity and precision of the casts left something to be desired. The "space" technicians tackled the job, used so-called investment casting, and produced superior articles. The production cost was a little higher, but it's all recovered, and then some, because of the operating advantages. What operating advantages? Well, incomparable reliability, much longer service life, better hygiene properties....

Star Flights and Daily Bread

The above-named things are not simply the product of the scientific and engineering thinking of Tekhnomash staff members. And they're not the solution of a design or production problem achieved by just any means. Every article has its own documentation, which makes it possible to compare it with similar models of the past or from abroad. "Cuts labor-intensity tenfold," "reduces mass by 15-20 percent," "mechanical properties are enhanced considerably." And the summarizing column is "economic impact." The figures there are in the tens of thousands, hundreds, millions. Has anyone tried to add all those figures up? And not just for Tekhnomash, but also for its "coworkers"—NPO Energiya, NPO Kompozit, the Lavochkin NPO, the Khrunichev Plant? After all, it would be a pretty hefty sum. And what's most vexing is that virtually any type of technology or equipment created for space programs could be used in the interests of civilian machine building for the production of peacetime products, but only a small portion of the innovations are being used today in the national economy. Why is that?

That the products are not series-produced and have high prices is a false argument. A high-quality, highly reliable article made of special materials can't be inexpensive. That's the way it is all around the world. And the saying "I'm not so rich that I can buy cheap things" is very apropos here. If the seal of a container, for example, is such that a leak of its contents wouldn't exceed a gram in 10 years, then that "article" is of super quality.

According to official data, the countries of the Commonwealth have some three million invalids who need prostheses. Several former "mailing addresses," among them Tekhnomash, have developed and built artificial legs and arms that are a match for real ones (here we have unusual designs and materials and other innovations). One woman marathon runner ran 40 kilometers on such a prosthesis, and nowhere were there any spots rubbed raw. The price of such a prosthesis is 20,000 rubles [R] (by world standards, that's cheap). But here's the sad thing—they couldn't sell the first batch of 20,000 prostheses. The same thing has happened with unique diagnostic equipment.

In medicine, the first prize goes to people's health. But in the national economy, it's the transfer of space technologies. There are some that the state and its departments and agencies must take under their guardianship. It's not for us to be pooling our money to buy an x-ray machine for a rayon polyclinic—the Ministry of Health should do that.

And another thing. Who, for example, is going to say what and how many of them need to be produced today and, especially, tomorrow? Who is going to say how many welding machines are needed for saturating the internal market, or diagnostic instruments, or regulated-nozzle spray guns, or blood-purification machines, or anything else, for that matter? What goods get preference? Where is the unified, balanced program of conversion?

The gamut of possibilities for Tekhnomash in the development of technologies and special equipment stretched wide: from welding heads, say, to fairly small automated bakeries. The former, as already mentioned, are intended for welding pipes and crowded, hard-to-get-to places and are in big demand in the industrially developed countries. It's mainly Russia itself who needs bakeries, because a good deal of the bread-baking equipment now in use reached retirement age long ago. Bitterly and with regret, I can say that the welding heads and the technologies for the automated bakeries are brought together by only one sad circumstance—both are manufactured in quantities that are too small. But then that's not the fault of Tekhnomash or the producing enterprises.

Conversion: A Mystery, or a Sacrament?

Conversion everywhere is, basically, making only its first and most difficult steps. Tekhnomash is no exception. The general director and his deputy for science spoke in very reserved tones about the possibility of making a decent profit in that field. For now, unfortunately, the talk is more about potential than about clear achievements. But the positive experience is already there, and, I think, it should be of interest.

"Our conversion—if I may speak not about anything in particular, but about the program as a whole—we see as our having to transpose the aerospace technologies that we have created into other complicated articles of hardware for the national economy," Bulavkin says. "What might those technologies be? There's a broad range: cryogenic equipment, turbine building, chemical machine-building."

"I would add," Valentin Alekseyevich Kazakov picks up the conversation, "that, in my view, the most interesting things are things like electron-beam welding in a local vacuum; consumable-electrode pulsed arc welding with welding-current pulses at a frequency of up to 10 kHz, which enables maximum elimination of defects such as porosity and interlayer buildup in multipass welding; a filtration-ventilation assembly for removing welding fumes from the welder's work space; electron-beam welding in a low vacuum; and in-orbit welding."

All that is fine. And there are a lot of plans at Tekhnomash, and they are capable of doing a lot, and it won't be the first time they have competed with the leading foreign firms. But who is financing the long-range projects today? My conversation partners sighed deeply.

"That's a sore point. State orders have been cut back dramatically. We're trying to get some orders centrally, others from sector enterprises, others from clients of other sectors of the economy. There are also difficulties with money flow. Often, it's late after taking a "stroll" somewhere, spiralling up the interest that's paid to the money wizards, and by the time it arrives, prices have managed to change drastically."

Tekhnomash is facing a lot of difficulties. The problem with personnel deserves special mention. There are highly skilled specialists at Tekhnomash. Lots of them. Candidates of science, doctors of science, academicians, professors, docents. Workers with golden hands, they could shoe the feet of a flea. How do you keep them in the association when all sorts of cooperatives and commercial structures are tempting them with big salaries and all the efforts of the directors and the personnel people at Tekhnomash depend on budgetary revenues. The shortage is strangling them. And the taxes, too. But the optimism is still there. "We're looking for—and we'll find!—ways" is what I heard from a lot of people.

How to Kill Two Birds With One Stone

They say that NPO Tekhnomash, when it was still in the Ministry of General Machine Building system, was the first "closed" enterprise to break through the wall of secrecy. About two years ago, it opened an exhibit called "Conversion of the Production Technology of the Energiya-Buran System in the National Economy" at the former VDNKh [Exhibition of the Achievements of the

National Economy]. And the very idea of that exhibit, as well as its contents, bore, unlike previous exhibits, a commercial nature. There one could acquire technologies, equipment, and industrial goods; one could place orders for the manufacture of a product; and one could sign contracts for setting up joint ventures.

Tekhnomash was one of the founders of an commercial international information center that has the exclusive right to sell on the internal and international markets other products of the NPO, to include the barter exchange of nonloaded equipment, raw materials, and parts and the establishment of a databank on new developments.

In a word, Tekhnomash has its own version of conversion. And it would appear that everybody wins with that approach. A confirmation of that consists in the demand that already exists for many of the technological achievements of the scientific-production association [Tekhnomash]. In addition, in the words of its directors, Tekhnomash's freedom to operate makes it possible for the NPO to set up contracts with enterprises based on various forms of ownership, to include leasing of production capacities to set up series manufacture of technical equipment systems.

But that's only part of what is possible. Among the alternatives being examined for the future is the long-term creation of joint ventures (to include those for the production of rocket-space hardware) that involve both Russian and foreign entrepreneurs. There's sense and rational behind that. Today, Tekhnomash had know-how that would be useless to certain domestic "civilian" enterprises because of their technical backwardness.

Tekhnomash's reputation abroad is quite good. The Americans, Japanese, and Germans might very well envy what it has developed. The association [Tekhnomash] has established contacts with more than 150 foreign firms, it is a cofounder of several joint ventures, and it is getting authorization for a license to sell its products to foreign firms.

The prices for its products? They're determined by agreement. And that not only makes the process of conversion economical, but also provides the NPO with a profit, some of it in hard currency. The smaller portion of the hard-currency revenues of Tekhnomash are to be spent on improving its research and laboratory base; the larger portion is to be spent on acquiring consumer goods. It turns out that because of the changeover of its production lines to the manufacture of civilian products, as well as because of the revenues from the sale of formerly defense and exclusively rocket-space products and technologies, the association is solving one of the fundamental problems of conversion—saturation of the internal market with consumer goods.

So what about the space future of Russia? Will we really scatter and destroy all that was done by our Fatherland as a great space power, a pioneer in many stages of achievement? At Tekhnomash, they categorically reject that.

Space exploration has become an inseparable part of civilization and our everyday lives, and it has proven that it is not expendable. Without satellites for communications, meteorology, navigation, geology, and other things, we would be "deaf" and "blind," we would "get lost in the oceans," we would "do mineral exploration the old way," we wouldn't "know what the weather is going to be tomorrow."

I left Tekhnomash with hope and assurance, with the thought that space exploration stimulates the development of the most advanced technical sectors. Its technologies, its materials, its experience are needed by everyone today. And tomorrow, we'll still need all that.

Russian Aerospace Conversion Center Established

937Q0077A Moscow ROSSIYSKIYE VESTI in Russian No 22, 3 Feb 93 p 3

[Article by Col-Gen Avn Vladimir Tsarkov, president of the Russian Center for Conversion of the Aerospace Complex, prepared by V. Khrustov, under the rubric "Economy-Reform-Society": "Center for Conversion: From the First Projects to the National Program"; first paragraph is source introduction]

[Text] A meeting took place of the founders of the Russian Center for Conversion of the Aerospace Complex, which is being created in accordance with an ukase of the Russian Federation president. The Council of Founders was headed (on societal principles) by the chairman of the Expert Council under President Oleg Lobov. Chosen as the president of the Center for Conversion was Col-Gen Avn Vladimir Tsarkov, who has served more than 30 years in the Armed Forces. At the request of the ROSSIYSKIYE VESTI correspondent, he spoke about the near-term objectives of the Center and the first conversion projects the Center is setting out to accomplish.

When you speak about the objectives and unique features of conversion in our country, you have to keep two things in mind. There has always been in this country an unmonitored request by the military department for budgetary monies for the material-technical support of objectives assigned to the Armed Forces. The curtain of secrecy in that area has been, to put it mildly, fairly expensive to us, the people, taxpayers. Now it is clear that a fairly large amount of that money could have been spent in the interests of improving the welfare of the people. If you go further, we should have determined long ago, of course, the composition, levels, and objectives of the Armed Forces needed for peacetime and for time of war, based on the optimal needs determined by the situation. Because keeping a little over 5 million people under arms with the level of development of our economy is an unproductive luxury. Had we thought about this earlier and gradually laid the foundation for

conversion, we wouldn't be taking the kinds of losses we're taking today, when we have to bring the composition and structure of the Armed Forces to optimal levels in very short periods of time.

But now that we've begun a dramatic reduction of the army and, accordingly, the budgetary appropriations for defense, we haven't it thought out in full, to tell the truth, and, of course, we suffered some big material losses because, after embracing broad-scale conversion, we hadn't underpinned it with a strategy or tactics. Conversion turned out very quickly to be an expensive diversion. In this country, it started out as a slogan campaign without any well-thought-out or coordinated plans and without any regard for the interests of either the development of peace or the defense capability of the country.

Today, the major mistakes of the first stage must be taken into consideration. In tackling the conversion of the most advanced and most expensive complex we have—the aerospace complex—we can't allow a repeat of the same mistakes. It's an area of production in which is concentrated all the best that domestic science, hardware, and technology have produced. And of course, the greatest wealth consists in the highly skilled, veteran specialists: scientists, designers, technicians, workers. Those are people who have worked their whole lives for defense and who have spent their whole lives dealing with modern technologies. We must not allow such a valuable treasure of acquired intellectual potential to be put out on the market for everyone else. And now we may be reaching a point at which those specialists run abroad, where they are greeted, by the way, with open arms. It's not just the Soviet nuclear specialists who are held in high esteem. I dare say the demand for rocket specialists and aircraft builders is just as great. Some of those who we can now call our foreign partners already know personally who they need.

For that reason, it's our state's job to reassign that potential and thereby preserve it for the Fatherland, keep it in Russia. And even support the change and prepare for it. In our dealings with the United States, Japan, and other developed countries, we must preserve, not destroy, the positions that we have achieved through the many—let me speak frankly—deprivations and limitations imposed on our own people.

A third objective in the area of conversion that pertains in full measure to our Center is this: in perfecting weapons and delivery systems (it's apparently too early to be talking about universal, total disarmament), we need to think about creating dual-purpose hardware. So that each and every assembly can be used for peaceful purposes. Which means we won't have to explode or cut up or melt down hardware whose creation took gigantic sums of money (for destruction, by the way, also takes a fairly large amount of money).

At the end of the 20th century, people have finally come to understand that cooperating with others is more beneficial than fighting or confronting them.

The consolidation of efforts in the exploration of space demonstrates quite clearly how amazing the results can be when we work together. Today, nobody is calling an international mission to Mars science-fiction any longer. From a technical standpoint, the mission is entirely feasible, and it's just a matter of time before it will be performed.

Which is why today there is no reason whatsoever to be exploring space by oneself. We must use the achievements of all countries to reach the goals of all mankind—scientific goals. None of that can be done without a solid information bank. To make intelligent decisions, one needs to have information, one needs to know what is being done in a given field, and not just in one's own country. If we create a good data bank, that will facilitate considerably the choice of the optimal alternatives. Then our Center will be able to make counterproposals to various firms (both Russian and foreign), playing the role of a unique middleman and coordinator; it will also be able to give the necessary advice to enterprises, departments, and even the government.

An important aspect of conversion that, for some reason, we often forget is the retraining of personnel. I recently visited the Omsk-based aerospace association Polet, which is headed by Valentin Ivanovich Zaytsev. It left a consoling impression on me: everything is being done there together—hardware that many plants could only dream of is not standing idle, and the personnel have not been cut back. And we have already proposed what, in our view, is a not a bad conversion project at all and in which the Omsk people are interested. We're also counting on the support of the government.

The former USSR manufactured 12,000 An-2 aircraft. They have served many local routes, and the North, the Far East, and Kazakhstan would be up a creek without that aircraft. But now we have this situation: in terms of the life of the fuselage, the aircraft could go on flying even longer; but the engines have gone past their service life, and we're not making them anymore. Poland is producing them and selling them, but at prices that our aviation enterprises can't accept. As a result, today more than half the fleet of An-2 aircraft are sitting on the tarmac. In the meantime, nobody is prepared to produce a new aircraft of that class, because huge subsidies are needed.

We have proposed the following program. Have it produced by the Omsk Polet plant and the Baranov Engine Plant, whose staff is ready to start in the near future the manufacture of an engine for a small-engine aircraft. That engine has up to 1,500 hp. The Antonov KB [design bureau] is beginning to prepare the documentation for a new modification of the An aircraft that will have expanded capabilities (range, lift capacity), but will have the same takeoff-landing characteristics. In a word, the problem is solved in the best manner, with the smallest possible infusion of money.

Thus, over the next couple of years, we can maintain the level of aviation that's needed by our economy and, at the same time, prepare for the manufacture of a new, modern aircraft of that class. The Ilyushin KB is tackling that task. We have already discussed the problem of the necessary investments with them, and we will be taking proposals to the President's Expert Council. Thus, we keep jobs without doing a radical retooling of production and we fill that niche in the aviation market. So we're looking for investors in that program. The first proposals have already been made. It's our hope that the An-3 will soon take to the skies of Russia, and the skies of other CIS countries, too.

There are government projects and their designs that affect the conversion of space hardware. Three commercial launches of American satellites will be made from the Plesetsk Cosmodrome.

Yet another area of cooperation is in the monitoring of space on a planetary scale.

Over the 35 years that space has been explored, there have been a good many problems associated with the littering of near-Earth space with manmade objects, which today number in the millions. Some of that trash presents a serious danger to space vehicles. But the early-warning radars and optical and optoelectronic systems on hand today are capable of monitoring space at distances of thousands of kilometers. And combining efforts—and that's on a commercial basis, too—will make it possible to avoid flying "blind" orbits and provide the maximum possible safety for orbiting space vehicles, as well as provide timely warning to the ground of any danger that comes about from space-based objects that are having problems.

So many of our firms are working on the development of communications systems (television, telephone, etc.). That represents a broad field of international cooperation when you think of the capabilities of space-based communications systems. After all, space-based hardware is ready, like no other hardware has ever been, for integration into the economy. I'm not just speaking of the capabilities for predicting weather or for surveying the Earth's surface in the interests of the environment. Day-to-day jobs are beginning to include providing communications to the hundreds of thousands of populations centers of Russia and monitoring oil-and-gas pipelines and the transportation of dangerous cargoes by rail. The prospects for conversion here are immense.

We've named here today just some of the jobs that the Russian Center for Conversion of the Aerospace Complex will be handling. The Center is a private organization, even though it is called upon to handle state and national problems. The state right now simply has no money to maintain such an organization. Although in the United States, for example, there are about 40 such centers, and each of them is akin to our scientific research institutes. And such centers sprang up simultaneously with military production.

It's easy to see that in the near future there will be a need for the creation of subsidiary centers of the Russian Center for Conversion of the Aerospace Complex in other sectors of industry or in regional industrial centers. Those issues will be resolved together with design bureaus and enterprises when it is decided to undertake a design project.

We are beginning with a fairly small center (the entire staff is 36 people) for the conversion of the aerospace sector, and the staff will invite the participation of scientists and specialists—both Russian and foreign—in their projects and programs. But in the future, the experience of the nation's first conversion center can be extended to other defense sectors as well.

NPO Energiya's 'Signal' Communications Satellite System to Compete With 'Iridium'

937Q0073A Moscow KOMMERSANT-DAILY in Russian 19 Jan 93 p 1

[Article by Mikhail Sergeyev, under the lead-in "'Energiya' Is Developing the 'Signal' Communications System": "'Energiya' Enters Competition With Motorola"; first paragraph is source introduction]

[Text] Russian space firms are entering a period of intense competition in two spheres that are the most commercially promising for them in the current situation: commercial launch services and the development of satellite-based communications systems. On 18 January, NPO Energiya announced that it had made the final decision to deploy the commercial Signal communications system, which may compete with the low-orbit Iridium communications system of the American Motorola firm. Energiya is planning to launch the first two satellites this year and, by the end of 1994, provide communications services to Europe and the CIS. By that time, there will be 48 Signal satellites in orbit.

The Signal system is to provide telephone, telex, and facsimile communications, as well as data transfer and personal calls without the use of the customary "dishes" of satellite communications. The system consists of a network of communications satellites capable of receiving and relaying the signals of standard radio telephones. Users of the Signal system would be state and private enterprises, transportation companies, mobile construction and assembly groups, banks, private individuals, with communications guaranteed for mobile users. In the words of the developers, the personal user station of the Signal system will cost no more than a color television, and as of today, user fees would be about 200 rubles [R] a month and R5 per minute. Energiya also announced its intention to ask the Russian Space Agency for a license to deploy the system.

All the operation in the Signal project are being financed by the International Concern for Space Communications KOSS with charter capital of R2.8 billion. The founders of the concern were commercial enterprises formed by staff members of rocket-space enterprises of Russia. The

total amount of money to be spent by 1998 for deploying the global Signal system is R4.3 billion (at current prices), whereas the cost of the Iridium system, whose operation is slated to begin by the year 2000, is estimated at $4.5 billion. Thus, in the words of KOSS Vice President Sergey Zagorodniy, the investment of monies in the Signal system provides a ruble-to-dollar conversion of one-to-one.

The small Signal satellites will be launched in a "packet" of two vehicles by the series-produced Kosmos launchers of the Omsk Production Association Polet or six at a time by the Tsiklon launchers of the Dnepropetrovsk-based Yuzhnoye Machine Building Plant. The Scientific Research Institute of Radio-Instrument-Making is manufacturing the system architecture and all the electronics.

As reported earlier in KOMMERSANT-DAILY (see the 19 December issue), the Motorola firm (U.S.) is working on a similar project involving the low-orbit Iridium communications system, which is expected to provide the same range of services that are provided by the Signal system. Talks are under way with the Moscow-based Khrunichev Plant regarding the use of the Proton launchers produced by that enterprise to deploy the Iridium system.

NPO Energiya telephone: (095) 516-47-26 KOSS telephone: (095) 158-84-92

Khrunichev Plant Assigned to Develop Commercial Space Launches

937Q0072A Moscow ROSSIYSKIYE VESTI in Russian 28 Jan 93 p 5

[Article by Sergey Gusyakov, under the rubric "Conversion": "The SS-25 in Space Orbit"; first paragraph is source introduction]

[Text] In accordance with a regulation of the Russian government, ballistic missiles will be used for commercial launches of spacecraft.

According to the regulation (No 2349-r, 16 December 1992), the work associated with the development of commercial launch vehicles based on the Proton ballistic missile has been assigned to the enterprise that manufactures that type of strategic offensive weapon—the Khrunichev Machine Building Plant. The Russian Ministry of Defense, together with the Russian Space Agency and the Committe of the Russian Federation for Defense Sectors of Industry, has been commissioned to present to the government within two months proposals for the construction at the Plesetsk Cosmodrome of a launch complex for commercial launches of space vehicles.

Furthermore, the Khrunichev Machine Building Plant, previously completely closed to foreigners, has been allowed to finalize a contract with a former "probable enemy"—the American Motorola firm—regarding the performance of three commercial launches of satellites of the space-based communications system Iridium. But part of the hard-currency proceeds from the launches of those satellites by the Proton launch vehicles—some $40 million U.S.—will be spent on executing the project for the development of the space-based Iridium communications system. It is recommended that the Khrunichev plant form a proper joint venture with another American firm—the Lockheed Corp.—for the marketing operations on the international space-services market.

Meanwhile, preparations are under way at Plesetsk Cosmodrome for the commercial launch of an SS-25 rocket that will lift an experimental communications satellite. The flight is slated for February, and if it is successful, the joint-stock company financing the project—IVK—will become the first in the world to have a mobile launch complex for commercial launches of small satellites. A closed-type joint-stock company, IVK was founded by a cooperative of the same name, the Moscow Voykov Plant, the Soviet-British joint venture IVK International, and the joint-stock company Center for Business-Related Scientific-Technical Collaboration. Its partner in the project is the science and technology center Kompleks, which brings together more than 100 of the enterprises that develop the SS-25 rocket. The rocket itself, which can be shipped to virtually any country, will not be sold to anyone: "IVK is merely offering launch services."

As of today, IVK already has nearly 300 potential customers interested in the launch of small satellites. Among the possible users of the services of the Plesetsk launch pads are American and European firms that account for nearly 80 percent of the total number of small low-orbit satellites. Lifting such satellites with the heavy launchers that are available in the United States is too expensive. But our ballistic missiles of the SS-25 and Proton type represent the best alternative for handling those kinds of scientific and commercial tasks.

Lozino-Lozinskiy Discusses 'Maks' Spaceplane, Conversion Issues

937Q0070A Moscow RABOCHNAYA TRIBUNA in Russian 22 Jan 93 p 5

[Unsigned interview with G. Ye. Lozino-Lozinskiy: "Cosmodrome on the Back of the 'Mriya'"; the first paragraph is an introduction; the last five paragraphs are a final commentary]

[Text] We learned with surprise: a commission has been organized in the Russian Academy of Sciences for conducting a careful search for sound ways to use the Buran multiply useable spaceship. After all, almost five years have passed since the single flight... And what have the creators of our country's shuttle been doing while it has been forced to sit idle? That was the question with which we began our conversation with Gleb Yevgenyevich Lozino-Lozinskiy, the general designer and up until now one of the most secret and powerful enterprises of the "defense complex," the Molniya NPO [Scientific Production Association].

"Misfortune already tumbled upon us in 1991 when orders for the Buran were reduced to 10 percent of the former work volume," states Gleb Yevgenyevich. "In one way or another it was necessary to think how to survive."

Q: The conversion ordeal has already lasted more than a year. It already has become clear in principle that it is possible to find ways and means not to lose all the talented people and on a slimmed-back level retain the glowing scientific-technical potential. Enterprises like yours are "extricating themselves," producing, for example, giant meat grinders on the basis of high technologies. There is now something else which is more terrible: from the assortment of products of the military-industrial complex we are observing mass disappearance of those "articles" which earlier had given rise to these high technologies themselves. Within a short time we risk lagging behind even where it was acknowledged that we had outpaced the West by 5-10 years.

Lozino-Lozinskiy: It is necessary to embark in directions which guarantee not only a rapid payback, but also progress. I myself have in mind two such directions: space and small aviation.

First we propose construction of an orbital aircraft of a size smaller than the Buran.

Q: Why? Will it sit side-by-side with the Buran?

Lozino-Lozinskiy: I hope that other future possibilities await it. The aircraft will become the second stage of a multipurpose aerospace system, the "Maks," whose design was developed at the "Molniya" NPO. It will put into space loads weighing up to 10 tons. That is, what is necessary in at least 80 cases out of a hundred. There are extremely few heavier satellites. Incidentally, our competitors, the Hotol in Great Britain, Hermes in France and Saenger in Germany are rated for the popular load of 8-10 tons. There are projects for such winged ships in the United States and Japan.

But now we can leave the other space powers behind, already having the most powerful liner in the world, the "AN-225," the "Mriya," a giant with a load-lifting capacity up to 275 tons, on whose back the Buran was transported, as were the blocks of the Energiya booster from Moscow and Samara to Baykonur.

Q: What is the connection here?

Lozino-Lozinskiy: The most fundamental. Indeed, the sense of the "Maks" is that the orbital aircraft will rise into space with the Mriya. In other words, we propose getting by without a booster. And these are the new properties of the launching systems: rapid launching from any region of the planet in any stipulated direction, routine docking in orbit without prolonged maneuvering, as is now required. There also is no need for complex cosmodrome facilities. As a result it is found that the cost of putting a kilogram of load into orbit by means of a mobile system is almost ten times less than by means of any booster. The low cost of launching means that the "Maks" will make it possible to be fully dedicated to the commercial use of space. And for the first time to get by without government subsidies. And once this is so, the need for launchings will increase, as will the number of variants of mastery of near space. There are those, for example, who are already seriously thinking about the organization of tourist trips around the Earth or sanitoria in orbit.

Q: That's impressive. But it must be remembered that the "Mriya" is constructed in the Ukraine, just like abroad...

Lozino-Lozinskiy: Is this suddenly so bad? Being engaged in advantageous and progressive work, it also is possible to sustain other neighbors. Especially those with whom we worked in constructing the Buran. Why would we not do good things together? And the government should immediately take measures not to lose our economic bonds with the republics.

Q: It seemed to us that the immediate effort should be made by the enterprises themselves, not the governments.

Lozino-Lozinskiy: I will not especially go into the matter and will cite only one example: the currencies are now different and there are customs problems... It wasn't the enterprises that are responsible for this. And as a result I cannot transfer money to our long-time partners in the Ukraine for any work. They cannot ship out their products... You sit here, the telephone rings and they say that we owe money to the people in Perm. You pay them whatever and do our calculations. Such a shuffling back and forth, take my word for it, affects everything.

Q: Gleb Yevgenyevich, you agree that you nevertheless have gained profit from the Gaydarov principle. You were put on short rations, they forced you, in essence, to extricate yourself. And in response you devised a great number of useful things. isn't that so?

Lozino-Lozinskiy: Joking aside, there's a certain amount of truth in that principle. Had there been a normal level of support and subsidy there certainly would not have been such high activity. It required an incredible amount of creative tension in order for our association to find an optimal way out from its critical state. But I fear that the "financial diet" went a bit too far. And the practical embodiment of the creative spark is extremely difficult.

Conversion work, even commercially very advantageous conversion work, requires initial financing. We are counting on that very much. Then it will be possible to launch the "Maks" program. There would be work for many factories and design bureaus which are now in a difficult position.

Q: Is it possible for an important defense enterprise to be induced to concern itself with conversion?

Lozino-Lozinskiy: It is possible if there is a government plan. Recall the year 1944. Then the first conversion for

our country began. And no one moaned, crying out help, help, we are going down, conversion is destroying us. There was none of that. When enterprises operate under a program their restructuring proceeds in a quite organized fashion.

Correspondent: Well, now is a different time...

Lozino-Lozinskiy: And nevertheless, I feel, there is no way to get around this without reasonable, I emphasize reasonable, state regulation. In the United States, for example, it is clearly expressed in a reduction in government orders. But in this case they do not plan and do not allow less than a 6 percent decrease. This is a volume which under market conditions allows strong enterprises to switch gradually to peaceful production. In our case, however, the immediate decrease is 60 percent or more! How is it possible for them to deal with this?

The "Maks" is therefore the work which the Molniya NPO proposes for the long haul. And it is inviting participation in an international association for its construction and operation on a commercial basis. The elements of a multipurpose aerospace system do not exist only on paper; many have already been worked out very well. The "Mriya" is flying. A prototype of a small orbital aircraft more than once has already risen into space under the code name "Bor-4." Some Buran assemblies and materials have undergone final testing in it.

More than 40 satellites with the "appropriate" mass of 8-10 tons are now launched each year. And so it will still be when space becomes accessible to almost all countries and even individual companies due to an inexpensive launching system.

The "Maks" is therefore an advantageous undertaking. But by no means is it the only one in the Molniya NPO program.

RABOCHNAYA TRIBUNA has already reported that on 18 December 1992 the first national "working" aircraft, the "Molniya-1," rated for 6 persons, took to the skies from the Zhukovskiy airfield near Moscow. Behind it stands a whole family of transport miniliners, simple, convenient and safe vehicles for different needs.

The "Molniya-1" has already gone into production at factories in Moscow and Samara. The plans call for the production of 150 aircraft per year. But large capital investments are required for further development, preferably from the state. Let's say, a billion for a starter. And what is interesting, it will pay for itself in a year. The profit, according to the most modest calculations, will be about 10 billion (in January prices). Plus tens of thousands of jobs.

Conference to Facilitate Private Entrepreneurship in Aerospace Sector

937Q0069A Moscow DELOVOY MIR in Russian No 241, 15 Dec 92 p 1

[Article by Svetlana Omelchenko, DELOVOY MIR reviewer: "Earthlings for Space"; the first paragraph is an introduction]

[Text] The Second International Scientific-Practical Conference on "Businessmen and the Economic Mastery of Space," organized by the Russian Union of Private Owners and the Moscow Union of Private Entrepreneurs, as well as the Zemlyane Association of Business Cooperation, has been held at the Russian Control Academy. Commercial banks, entrepreneurs, representatives of the Russian and Moscow governments, scientists, production workers and businessmen participated in the conference work.

The conferees endeavored to define the specific directions in cooperation between enterprises of the aerospace complex and the system of private entrepreneurs taking shape in Russia, to assist in finding among them new investors for space programs, on the one hand, and on the other hand, to assist entrepreneurs in finding promising projects for advantageous placement of their capital.

About 50 leading aerospace complex specialists and Russian business leaders presented their proposals for solution of different economic problems in the sphere of ecology and conservation of resources, transport and communication, TV and radio broadcasting, space biology and medicine, new materials and technologies.

More than 30 sections contain the full list of problems to be solved by the Priroda scientific research organization and the Mir orbital complex, including prediction, observation of the dynamics of development of calamities and evaluation of their consequences. Specialists of the Kompozit Scientific Production Association propose experimental-industrial production of bioengineering products under weightlessness conditions on a commercial basis: growing of crystals, production of exceptionally pure substances and protein medicinals. Their fabricated products are unequalled elsewhere in the world. Many very strong titanium alloys developed in the course of constructing the Buran contain a lesser quantity of costly and short-supply elements than those used abroad and may find broad economic applications.

In order to facilitate more effectively the bringing together of the advances of cosmonautics and private capital of Russian and foreign entrepreneurs the organizers of the conference decided to carry out such measures twice a year. The next conference will be held in 1993. Contact telephone: 281-81-92.

NST General Director Interviewed on 'Zerkalo' Satellite Project

937Q0069B Moscow DELOVOY MIR in Russian No 241, 15 Dec 92 p 9

[Interview between Yuriy Markov, spacecraft test engineer, and N. A. Morozov, NST general director: "Why a Space Bank?"; the first paragraph is an introduction]

[Text] Recently I met with N. Morozov, general director of the NST Company (NOOS Space Technologies Ltd.). He is 50 years old. In the recent past he was the leading designer at one of the principal aerospace enterprises in Russia, the Scientific Production Association (NPO) imeni S. A. Lavochkin.

Markov: Nikolay Aleksandrovich! I heard that you have visited Cambridge in the United States?

Morozov: Yes, on the invitation of the Massachusetts Institute of Technology to attend the First International Congress on Transportation and Telecommunications. Our press for some reason or another gave no coverage to this congress.

Markov: Who participated in the congress?

Morozov: Motorola, Marconi and other global companies, as well as leading specialists, representatives of governments, banks and the press from many countries of the world.

Markov: Was Russia solidly represented?

Morozov: Impressive delegations from the government and Supreme Soviet were present. But the NST was the sole Russian company receiving an invitation to this forum.

Markov: How do you explain this?

Morozov: The great interest in our space technology and in particular, in the "Zerkalo" satellite communication system.

Markov: Just what is this system?

Morozov: Very briefly, it is a fundamentally new space communication system making it possible to increase the rate of data transmission by a factor of 1000 in comparison with the present-day rate and thus to ensure high-speed (including computer) exchange of data between stock markets, banks, enterprises and offices...

Markov: By what means?

Morozov: A lone satellite with a multiray (targeted!) relay system hovers in a geostationary orbit and a far-flung communication infrastructure is organized below.

Markov: Who will organize this system?

Morozov: The "Zerkalo" is being developed by three "giants." The head company for the satellite is the NPO imeni S. A. Lavochkin (general director A. Baklunov, general designer V. Kovtunenko). The development of surface receiving-transmitting radio stations and the onboard radio system is assigned to the Russian Scientific Research Institute for Space Instrument Making headed by L. Gusev, and the development of the control system is the task of the AP NPO headed by V. Lapygin. (Incidentally, one of the recent and major developments of this association was the control system for the multiply useable Buran spaceship.)

Markov: I know that German specialists, developing the "Romantis" project, similar to the "Zerkalo," retreated due to its cost: about 7 billion German marks. Who is this Croesus who is financing your project?

Morozov: The NOOS Group International, of which the NST Company is an integral part.

Markov: But let's return to Cambridge...

Morozov: At the congress there was broad examination of the problems of the CIS and Eastern Europe in the field of information, transportation and communication. Individual reports were devoted to the problems involved in retaining the workloads within Russia. Who will risk investing capital here if there is a virtually complete absence of a control system guaranteeing the inviolability of property?

The Americans are thinking about establishing an ultramodern international airport in Russia (there is a plan for reoutfitting Domodedovo) and seaports. Throw open the gates! There we have the principal task on the threshold of multilateral cooperation.

The delivery of documentation and its reliability are causing serious concern. How to prevent forgeries? How to ensure verification of the signature when transmitting information through communication lines? These problems also were in the field of view of congress participants.

A second major set of problems involves the possibility of financing of the Russian transportation and communication projects. The Americans are ready to invest money. But only in the real thing!

There are rigid financing frameworks. American business circles, as I understood it, will cooperate with us with the satisfaction of two conditions: first, a privatization process is necessary because they prefer to deal with private companies. (I note that Bill Clinton also spoke of this after his election as president of the United States—Yu. M.) The second is private careful expert evaluation of the status of credits and subsidies.

Markov: Was there practical gain from your participation in the congress?

Morozov: Without question. On the initiative of the American side conversations were held with both governmental and private investors. A continuation of the contacts is planned.

In general the conference made an enormous impression. As did the good will, openness and hospitality of the Americans.

Markov: How did you overcome the language barrier?

Morozov: At the congress there was simultaneous interpretation by the personal interpreter of President Bush and Sergey Anatolyevich Shteynman, NST technical director, participated in the talks and discussions. He is an excellent specialist and knows English extremely well.

Markov: What are you busy with now?

Morozov: Immediately after returning from Cambridge the Commission on Frequencies approved the "positioning point" for the "Zerkalo" satellite: 88.1° over the Indian Ocean.

Markov: And its latitude?

Morozov: It will be at the equator!... The working documentation is being prepared as fast as possible.

Markov; And when the launching be?

Morozov: In May 1995.

General Designer Lozino-Lozinskiy Discusses Past Space Policies, New Directions

937Q0068A Moscow VOZDUSHNYY TRANSPORT in Russian No 50, Dec 92 p 7

[Interview between S. Omelchenko, cosmonaut-researcher, VOZDUSHNYY TRANSPORT correspondent, and G. Ye. Lozino-Lozinskiy, general designer and general director, Molniya NPO: "Without Intelligence a Collapse May Occur"; the first three paragraphs are an introduction]

[Text] The universal delight with the first successes of our cosmonautics was replaced rather rapidly by indifference and recently in society there has predominated a sharply negative attitude not so much toward cosmonautics itself, as to the truly great expenditures involved. And this change in attitudes has occurred within a single generation. Meanwhile, an enormous scientific and technical potential has been concentrated in the space branch, causing the envy of the best-developed countries. In our country for the time being more than 1 million highly qualified specialists work in the space field, not counting servicing personnel.

Can cosmonautics provide for itself, be an eternal parasite, or must it be content with the fact that Russia has already played its historic role as the pioneer in space conquest, and now, engaged with far more urgent problems, must it pass from the scene?

We will attempt to find an answer to these questions together with Gleb Yevgenyevich Lozino-Lozinskiy, general designer and general director of the Molniya NPO, member of the International Academy of Astronautics, honorary member of the Russian Academy of Cosmonautics and member of the International Engineering Academy, relying on the experience of a long and active 83-year life.

Lozino-Lozinskiy: The attitude of society toward cosmonautics is closely intertwined with the real conditions of life. There was an enormous, grandiose success: the first satellite and man's first flight into space. And society then felt itself on the rise, the living conditions of people were on the rise for those who had lived through the war, occupation and devastation. Our attainments in space seemingly demonstrated the correctness of the selected course and seemingly confirmed that everything which we were doing would favor an improvement in the life of everyone.

And then began the day-to-day work on ongoing mastery of space with all the difficulties involved, sometimes with failures, errors and tragedies. Space science and practical activity became detached from the specific life of society and its needs. But indeed the hopes of the people for improvement were not realized. You yourselves know that life has become increasingly worse.

And today we are concerned not so much with a search for ways to improve our life as with the directing of energy in search for the guilty; we are seeking them in the past, since after all no one wants to admit their guilt. Suddenly all are recollecting that excessive expenditures were made on defense (space, it must be admitted, also was defense). Considering our poverty the excessive expenditures on space yield results which are too little in comparison with our present-day needs. But results also cannot be realized quickly.

Omelchenko: Gleb Yevgenyevich, do you feel that there were no serious mistakes on the road which our cosmonautics traveled?

Lozino-Lozinskiy: If you are talking about the number of errors, a comparison must be made not with those which are becoming evident only after years and decades (afterwards always more evident), but also with the road traveled by other countries in this direction.

Omelchenko: In the United States the legislation on astronautics was adopted three years prior to the launching of the first satellite. In our country the first draft of such a law appeared only recently.

Lozino-Lozinskiy: The lack of a law did not, from my point of view, interfere with our being first and exerted no appreciable influence on the course of space mastery.

Omelchenko: But at what expense? As much as the people could endure, that was what was thrust upon them. In the pursuit of priorities no sums were spared and resources were diverted from the social sphere to the detriment of living conditions for the people. The American law immediately ensured that commercial advantage would come from space research.

Lozino-Lozinskiy: The fact that the Americans have a law even today has not led to coverage of expenditures on space research by commercial organizations. Ninety percent of space research there continues to be at the expense of the government.

In our country all the organizations making use of space production were state organizations and there was no special rationality in the shifting of money from one government pocket to another. But now, when the state is trying to dissociate itself from everything, when we are passing on to a market economy, it is exceedingly necessary to begin to make use of all our attainments on a commercial basis.

Omelchenko: Nevertheless American specialists assert, and this is confirmed by our specialists, that for each dollar invested in space programs there will be two or three dollars of net profit just from the industrial use of new technologies. In the long run the taxpayers will come out ahead. Does our cosmonautics intend to return the people their due?

Lozino-Lozinskiy: In actuality the American lunar program paid for itself sevenfold, according to assertions by the Americans, only due to the large-scale use of what was achieved on the Earth, in industry. We also use a whole series of attainments in our country. For example, for constructing cryogenic hydrogen tanks we developed a special aluminum alloy, solid, resistant to different temperatures. It found application in aviation. Unfortunately, not all the development work in space science and industry is being used with the same effectiveness as abroad. But this is not attributable to the lack of a law, but due to the weakness of scientific-technical organizations and the economic links among them.

Omelchenko: In any American city it is possible to find items and articles on open sale which are used by astronauts during flight: fountain pens, electric shavers, spaceship food in special packaging, to be sure, somewhat more expensive than ordinary goods...

Lozino-Lozinskiy: Excuse me for laughing. You are correct in saying that I have nothing against it. But I laughed because we cannot supply the population of our cities even with such a simple product as cows give. Despite the acute shortage of milk it is cheaper even to pour it out on the ground than to transport it to us. And it is being poured out. And with our enormous disorder and problems with ordinary feeding of people it is somewhat untimely to speak about consumption of such space food. Although you are absolutely right in saying that certain attainments can indeed be used successfully in everyday life. And obtain a profit from them.

With respect to debts. The last two years our workers have been engaged in the development and construction of aircraft for passenger and freight transport, business flights, the sanitary and patrol service: the "Molniya-1." The "Molniya-100" will serve for these same purposes, but also for aerial photography, geological, ice and fish reconnaissance, forest patrol service and airborne operations. The "Gerakl" transport plane can transport on an external suspension heavy large-sized loads weighing up to 400 tons, as well as passengers in a removable tourist class module. There also are other developments. We are rolling out the "Molniya-1" for tests.

This six-place triplane of somewhat unusual design, more resembling an automobile, will consume three times less fuel than for the transport of the same number of passengers and freight in the An-2 and L-410.

Omelchenko: Is this the result of conversion? What made this necessary for you?

Lozino-Lozinskiy: The Molniya NPO was established 100 percent for supporting work on a multiply reuseable space system, in particular, for the Buran. This spaceship is not part of the defense arsenal, and therefore the word conversion can be used only in the sense of a change in the field of activity for some of the workers.

Now the Buran occupies less than 10 percent of the total workload of the Molniya NPO. The limit of the allocated sums may attain a critical point below which the volume of financing will be unable to ensure continuation of the work. The real threat of a loss of skilled specialists has arisen. A personnel drain has begun. Many commercial organizations engaged in solution of computer control problems are extremely interested in our specialists. And we are now faced with the problem of finding work and salaries for them. This would make it possible to hang on to people, at least the most experienced and the most knowledgeable.

This transition was and remains painful for us. The experience in work on the Buran is not always helpful. The problems which must be solved when developing and constructing a spaceship differ from those which arise in the course developing subsonic aircraft. The number of subdivisions is becoming excessive, which causes social stress during the restructuring period.

There are also other difficulties. Closely related organizations are changing; a need is arising for new communication links which would serve as support for the new work directions. Earlier design bureaus and factories were concerned with one task, but now with something else.

We have succeeded in designing many models of new aircraft during these two years but really only one has been completed.

Omelchenko: The Buran has absorbed a lot of money. Do you consider work on it to have been in vain, undertaken inopportunely for our country?

Lozino-Lozinskiy: Without question I am convinced that this was very correct and very timely. Look at the interest which was displayed in the organizations which worked on the Energiya-Buran system by the well-developed countries. Both the United States and Europe feel that our attainments and experience can be applied

to the maximum degree possible. Let's assume that we will never launch the Buran again. Expenditures on it are already working. My company has concluded agreements with European companies on different kinds of development work to be carried out on the basis of the Buran.

Omelchenko: And nevertheless the funds do not suffice not only for continuing research, but even for preserving what has been done. Ahead will we have decay, a loss of what we already have?

Lozino-Lozinskiy: I see only one path forward: to continue to work on the basis of the experience accumulated in constructing multiply useable space systems which would ensure attainment of the tasks set before the Buran: reducing the cost of putting a payload into circumterrestrial orbit by a factor of 10 in order to make space research profitable. For all practical purposes both the American shuttle and our Energiya-Buran are for one-time use because the most costly element is the system for putting the spacecraft into orbit. The control of operations of the system for putting the Shuttle into orbit involves thousands of specialists who receive their pay regardless of the number of launchings. The coverage of expenditures for maintaining the personnel and infrastructure in the United States amounts to more than 1 billion dollars. With six launchings per year 150 million dollars are added to the cost of the Shuttle.

In front of us is a mockup of the "Maks" system, which can put a load into space at a cost 10 times less than existing systems. The expenditures are sharply reduced due to airfield servicing of the spaceship; the enormous sums on the maintenance of launching facilities are unnecessary.

The shortage of funds for the time being is reflected only in the rates of the work. Indeed, in working on the Energiya-Buran system we created an enormous laboratory-test stand base which was viewed with envy by all of Europe.

Omelchenko: And who's going to pay for this now?

Lozino-Lozinskiy: This will be the first system which could be developed without state subsidies. In 10-12 years it will completely pay for itself and yield a profit. For the first time we will be able on a sound basis to speak of the commercialization of space mastery. The reduction in the cost of launchings will make it possible to broaden the range of problems to be solved in space.

But the further mastery of space is not within the financial capabilities of any one country. It is necessary to combine resources and efforts. Government resolutions on cooperation with European countries in work on a multiply useable launching system have been adopted. We have convinced the Germans and the French that the time has come to give up on the vehicle which they named the Hermes. The British also have expressed faith in the good prospects of our development work.

Omelchenko: Among many soberminded people some of our recent transactions in the space field give rise to a well-founded uneasiness. For example, the exchange of cosmonauts with the United States, as a result of which a Russian cosmonaut will be detailed to an American ship for a 13-day flight, whereas their astronaut will spend 3.5 months in our Mir orbital complex. This will be a physician and indeed there is a well-known interest in the medical support of prolonged flights, experience with which only we for the time being have had. Our cosmonauts, however, have been denied even a space walk opportunity.

Lozino-Lozinskiy: This transaction, unfortunately, was evidently politically necessary. Outwardly it would seem that everything is being done on an equal basis, but the advantage falls to the American side.

Omelchenko: Does it not alarm you that such a tendency also may spread to other joint projects?

Lozino-Lozinskiy: The clumsiness and lack of skill in our interrelationships with foreign partners is causing much chagrin. The luster of the dollar is eclipsing reason, but for momentary advantages we are risking the loss of a very great deal. We are putting foreign scientists into our orbital complex without any advantages for ourselves, and so-called black boxes to which we have no access...

Omelchenko: What do you feel like? A politician, a scientist, an administrator, an entrepreneur?

Lozino-Lozinskiy: Not a politician. More likely a practical worker. A practical scientist. Practical work without science won't carry you very far. I have no doubts as to the enormous possibilities afforded by space. Throughout the world we are regarded as the outstanding space power. But a collapse may occur without intelligence and energy. I am concerned that this does not happen.

Omelchenko: Thank you.

NPO Energiya's Collaboration With U.S. Firms Reported

937Q0067A Moscow KOMMERSANT-DAILY in Russian 23 Dec 92 p 1

[Article by Mikhail Sergeyev, under the rubric "Contribution of Russia to Freedom Space Project": "Russian 'Energiya' Will Rescue American Astronauts"; first paragraph is source introduction]

[Text] Yesterday saw the successful completion of the first stage of operations in the contract between Scientific Production Association [NPO] Energiya and the American National Aeronautics and Space Administration (NASA) that calls for the participation of the largest space enterprise in Russia in the program for developing an emergency rescue craft for the American space station Freedom (see KOMMERSANT-DAILY, 12 November 1992).

The Space Station Freedom project, the largest of space project in the world today, calls for the creation of a permanent orbital station with changing international crews. Construction of the station is slated to begin in Earth orbit in 1996 or 1997.

Fighting for the right to take part in the program for the development of a reliable rescue system for the Freedom station are the largest aerospace companies in America, Rockwell and Lockheed. NPO Energiya is the developer of the reliable, relatively inexpensive Soyuz-TM transport craft, which can also be regarded as a rescue craft. NASA itself, Rockwell, and Lockheed have turned to [NPO] Energiya with a suggestion that versions of the NPO's participation in that project be studied, and at present, Energiya has reached an agreement both with NASA and with both the competing companies.

In the already completed stage of collaboration, in the context of a Rockwell order, a modified universal docking port that could be installed on the Space Shuttle and the Soyuzes and on the Mir and Freedom stations was tested on Energiya stands. In the end, NASA officials signed a document concerning the fundamental possibility of the use of Soyuz-TM spacecraft as emergency rescue craft for the Freedom station, "since the Russian craft meet the requirements made by NASA for crew rescue systems." In the words of the project operations director on the Russian side, Energiya Deputy General Designer Oleg Bobkov, the Soyuz-TM spacecraft already has a high degree of compatibility with the Freedom station (only the power-supply and radiocommunications systems need to be adapted).

In 1993, a "nonflying" version of the Soyuz-TM bought from Energiya by Lockheed will be sent to the United States, and the Americans will be able to perform all the necessary ground tests on it and will even be able to train astronauts on it. A complete list of modifications needed for the participation of the Russian spacecraft in the project will also be determined and agreed upon. Based on the results of that stage of collaboration, a final decision is to be made on the use of the Soyuz-TM as emergency rescue craft for the Freedom station.

According to unofficial sources, modification of the Soyuz-TM for use as emergency rescue craft will cost the Americans at least several tens of millions of dollars.

Observers feel that Energiya is certain to have a place in the Space Station Freedom project and, consequently, in the U.S. budget. Problems with the financing could arise in the U.S. Congress only, which is requiring that space collaboration with Russia help create new jobs in the U.S. aerospace industry.

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'Maks' Small Shuttle Viewed as Possible Successor to Buran

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[Article by Sergey Leskov, "Buran Goes Into Retirement. Why Russian Specialists Are Drawn to a New Space 'Shuttle' Project]

[Text] Perhaps there is no other space project which evokes such public interest as multiply useable orbital aircraft. Even now each launching of the American Space Shuttle is viewed as a sensation and any communication on the planning of national space shuttles in Great Britain (Hotol), Germany (Saenger) and France (Hermes) is a likely candidate for making the headlines.

Early in November still unofficial communications appeared that China, recently actively advancing into the ranks of leaders in world cosmonautics, is developing a program for multiply useable spacecraft. During the next 10 years a Chinese variant of a "shuttle" will be launched into space from a special cosmodrome being constructed 200 km from Jiuquan (in the northern province Gansu), the work being done "exclusively with reliance on their own resources."

In the flow of foreign information on this subject somehow it has been forgotten that in our country work has been carried out and continues to be carried out in the field of multiply useable spacecraft. In November 1988 the Soviet Buran had already made its first test flight, crowned with total success. It is true that this variant of the Buran was experimental, not being constructed to its final specifications. In particular, due to the absence of life support and heat regulating systems the Buran could not take a man aboard and was forced to make its exhibition flight in an unmanned automatic mode. This work has not been completed even today.

Nevertheless, the directors of the space branch have not ceased to convey to the public the idea that the Buran embodied the best advances in science and technology and is entirely necessary in space research. It always was risky to criticize the Soviet shuttle because it was shrouded in an atmosphere in which outspoken statements were regarded as a lack of patriotism. And, incidentally, one of the last mass handouts of high achievement awards in the crumbling USSR was precisely for work on the unfinished Buran (which, however, was extremely symbolic). Finally, precisely as a sign of high recognition to the Soviet shuttle a specialized council at the Energiya NPO [Scientific Production Association] on an unprecedented basis authorized for space industry directors the award of highly coveted doctoral degrees without the presentation of the dissertation work necessary for mere mortals.

But now it will soon be the fourth anniversary that this amazing Buran has been "laid up" on the ground; its second flight has been postponed repeatedly. Expenditures on the Buran already have exceeded 20 billion

rubles in the old prices and no one knows how much additional investment will be required. The most sorrowful thing is that even if the necessary sums are found for finalizing the ship, our shuttle has nothing to do in orbit. The very idea of a multiply useable ship is unquestionably promising. But in cosmonautics today there is a virtual absence of payloads (even for the advancing Americans) with a mass of 25-30 tons and the Buran resembles a heavy freighter which has been assigned to make voyages with empty holds.

Now it can already be acknowledged that the atmosphere around the highly touted Buran has by no means been free of clouds. Many leading specialists criticized the very concept of a spacecraft which limited to a minimum the possibilities for the crew to control the ship. Several of our authoritative cosmonauts, violating their inbred traditions, in the mid-1980's wrote a strong collective letter to the directors of the all-powerful military-industrial commission. However, despite many comments, work continued on development of the approved project, sent on to the higher authorities, virtually whose only merit was its sufficient correspondence to the American Space shuttle. And, it appears, a long list of losses (Stankyavichus, Levchenko, Shchukin, Konopeko) of top-level pilots, in training for flight in the Buran, by no means is just chance, but a result of nervous overstrain, worry, exhaustion and a lack of confidence.

As Professor N. Melnikov, at that time deputy chief of the Flight Test Institute, recalls: the entire atmosphere of work on the Buran in the best traditions of the system was dedicated to monopolistic practices, the dictates of the developer. The interests of the mission were shoved into the background and the quality of the final product, as has happened more than once in other branches, really meant very little. Other values assumed importance. As Professor N. Melnikov says figuratively: "the developer took money for soap, but succeeded in making an awl, and all the skill involved was in while making an awl, pass it off as soap." Under these conditions one can only be surprised that due to the enthusiasm of many groups of workers the Buran advanced as far as it did.

In the words of G. Lozino-Lozinskiy, general designer of one of what until now has been one of the most secret "defense" enterprises, the Molniya NPO, plans call for the Buran to make its second flight in the second half of 1993 and this will again be in an unmanned mode. In the course of this flight plans call for docking with the Mir orbital station and prolonged, over some days, work of the crew aboard the space aircraft. The ship is now at Baykonur, it is for the most part assembled and is undergoing inspection tests.

But now they have decided to speak frankly about the Buran. G. Lozino-Lozinskiy in the course of our conversation sadly admitted that the Buran was constructed despite his opinion, under the pressure of "highers-up" and, in essence, to catch up with the American "shuttle." Now the 83-year old designer is making an attempt to return to his once rejected proposal and to construct a space aircraft smaller in size than the Buran.

Statistics show that during the last five years 85 percent of all the satellites put into orbit have a mass up to 10 tons. Space aircraft are now being developed which are rated for such a load: in Great Britain (Hotol), in Germany (Saenger) and in France (Hermes). Even in the United States the Space Shuttle is being subjected to increasing criticism and a single-stage aircraft of smaller size is already being developed, with 5 percent of the NASA budget being allocated for this purpose.

Russia, or to be more precise, with allowance for far-flung cooperation, the entire CIS, is in a more advantageous position than the other space powers. The fact is that we already have the finalized powerful "Mriya" aircraft, capable of carrying aloft a load of 250-270 tons, from which a light, multiply useable ship can be launched into space. Now the Molniya NPO has completed rough designs of the "Maks" system, constructed on this principle. It is the opinion of G. Lozino-Lozinskiy that the experience accumulated at the Molniya NPO makes the development of the "Maks" spaceship realistic in six years.

But this will require a great deal of money. It is easy to imagine what attacks are being launched against the new expensive project by other general designers who will regard it as nothing more than an encroachment on their share of the scanty cosmonautics budget. The Energiya NPO, where the Energiya superbooster and many Buran systems were constructed, is evidently reacting particularly painfully to the new project. However, G. Lozino-Lozinskiy is looking at the new project optimistically and is hoping to evoke interest from commercial organizations, which today require specifically small satellites for different purposes. The participation of commercial organizations will make it possible to reduce state expenditures on the "Maks" to a minimum. Incidentally, in the United States not less than 30 percent of all space launchings are being financed by the private sector.

Another way to solve the financial problems is international cooperation And this possibility is becoming increasingly realistic. The British and French, in constructing the Hotol and Hermes colliding with problems which they hope to solve with our assistance and our technology, have already turned to the Molniya NPO with proposals. The problems involved in international cooperation and defining the most promising directions for multiply useable space systems were discussed at a conference held in the autumn in Moscow with the participation of the largest aerospace companies of Europe and the United States.

But we must solve the main problem independently. Why does Russia, the CIS (we recall that the "Mriya" is built in the Ukraine and the cosmodrome is located in Kazakhstan), need the "Maks"? It is scarcely possible to agree that the Buran embodied, as its partisans never cease to repeat, the best scientific advances, if the laws of economics, not the least of the sciences, were not taken into account in its creation. Computations show that the "Maks," putting 10 tons onto orbit, will be profitable with 30 launchings per year. This greatly exceeds the modest appetites of today's cosmonautics. And in order for the expenditures on the new, be it even a technically reproachless system, to be justified, a careful economic analysis is required. For the time being the construction of the "Maks," with the already available "Mriya," is estimated to cost 2 billion rubles in 1991 prices. However, expenditures on global projects within our country have the habit of increasing incredibly. And, as the general designer G. Lozino-Lozinskiy already is convinced, it is primarily commercial profitability which can serve as proof of the justifiability of multiply useable space systems.

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